AMERICAN
DENTAL
JOURNAL

9

1910

ORIGINAL CONTRIBUTIONS

FIIVE GREAT PROBLEMS IN DENTISTRY.

The Five Leading, Unsolved Problems in Dentistry are and have been—

THE AMALGAM FILLING
PHOSPHATE CEMENTS,
CARIES AND EROSION,
OBSTINATE PYORRHOEA &
ORAL PROPHYLAXIS.

This paper will discuss:

Amalgam Alloys and Amalgams.
Elementary Metals, Methods of Making.
Physics, Chemistry and Logical Results.
Physical, Chemical, Molecular and Granular Constitution of Crucible Melt Alloys and Amalgams.
Specific Causes of Bulk Changes in Amalgam Fillings.
Coated Molecular-Granular and Coated Granular Alloys.

RIGHT METHOD FOR MAKING AMALGAM ALLOYS.

BY J. OXFORD KELLER, D. D. S.

AMALGAM QUESTION IMPORTANT. The Amalgam question is important because there are so many amalgam fillings. It is estimated that about three-fourths of all filling work is done with amalgam. It is the only permanent, plastic material. About three-fourths of all amalgam fillings inserted, made with alloys under the old system of construction, will expand, contract, tilt, crevice or black ditch, so as to be seen with the naked eye within one to five years. Much has been said about excavating the margins of cavities along lines of cleanliness. Black says, "the margins of a cavity must

be laid down upon the areas of tooth structure that are relatively immune to the attack of carious-producing organisms in order to prevent further recurrence of decay." He formulated well for outlining cavity margins, but it is said that the skillful dentist, by instinct, cuts cavity margins along lines of cleanliness. He is generally forced to do so, to gain operating access. But again, much less benefit will result from margins along lines of cleanliness, if the cavity is filled with an amalgam that loses two-thirds of its strength inside of two years and black ditches or shrinks and crevices along said lines of cleanliness. It is much more important to have a filling that will maintain its marginal strength than to observe lines of cleanliness, because a filling with maintenance of margins along lines of uncleanliness will give much better services than a filling which black ditches and shrinks along lines of cleanliness. If the filling shrinks and black ditches, lines of uncleanliness would result in areas of cleanliness; hence, the necessity of good amalgam fillings. Many times better to have invented an alloy with right physics than to have phrased a formula for cavity margins on lines of cleanliness.

About thirty millions of amalgam fillings are inserted annually in the United States. Considering harmful bulk change conditions, which result in so many of them and tendencies to leakage and recurrent decay, there is no one problem in all dental science so important as an amalgam filling which will maintain marginal and structural integrity. Stability of amalgam structure and retention of color are fundamental properties to be gained. Every other problem in dentistry sinks into smallness in comparison with amalgam filling work, because of such harmful results. The skillful dentist can avoid the use of amalgam because he is well remunerated for his expertness in cast-gold inlay, gold filling, porcelain art, and gold inlay filling work. For counter reasons the average dentist must largely insert amalgam fillings. Of the 40,000 dentists in the United States, about 400 are experts, 4,000 skillful, and 35,000 average dentists. These 35,000 do over four-fifths of all dentistry. They insert about nineteen-twentieths of all amalgam fillings. Considering resultant conditions an amalgam alloy which will make fillings with stability of structure, maintenance of margins, and high retention of color, would be worth more to dental science and art than all other discoveries heretofore made in dentistry. Such fundamental betterments in the 30,000,000 amalgam fillings inserted annually would be top-notch progress. It is said that gold fillings and inlay work by the average dentist is a failure. If true, this is strongest proof in favor of good amalgam fillings. The average dentist is but little encouraged by the expert and skilful dentist, yet he is, has been and always will be.

AMALGAM PROBLEM DIFFICULT. The amalgam problem is not only important but it is very difficult. It has engaged the study of the ablest men, both in the physical sciences and dentistry; yet no material or fundamental improvement or discovery have been made by them. Harmful bulk changes still continue. They may be very harmful, yet not visible to the naked eye. Bad physics and construction are much more at fault than bad dentistry, but the

dentist by carelessness may make "bad" worse. The following paragraph is a quotation from Keller's Amalgam Principia, page 4, and gives one of the leading reasons why the amalgam problem is very difficult.

MOLECULES AND GRANULES INVISIBLE. WHY? Because the amalgam alloy metals are near the same color. When silver, tin, zinc, copper, and other metals are melted together, usual percentages, the physical identity of each metal is lost. Neither molecules nor granules can be seen with the naked eye, nor through the lens of a high power microscope, in an alloy ingot made with any two or more of them. Melting the metals together makes a complete conglomeration, a lost identity, and causes an atomic, molecular, granular and physical constitution which no human mind can understand. If the molecules or granules of the elementary metals in the amalgam alloy ingot could have been seen, either with keen eyesight or lens, the amalgam problem might have been solved during the early years of amalgam history. Bulk changes in amalgam fillings could not be comprehended except by a reasoning process from the part through to the whole, into and through the amalgam alloy ingot into the amalgam mass, from the particular metal to the general or completed amalgam mass, and from the individual metal into the universal amalgam. This is inductive method of reasoning and founded on laws of sound logic.

For further study of "Amalgam Problem Difficult" the student is referred to Keller's Amalgam Principia.

In this paper the following definitions, physics, chemistry and experiments should be observed. They will be referred to by numbers, as follows:

No. 1. An atom is the smallest particle of matter known in chemical action.

MOLECULES, Classes. They are elementary, physical and chemical.

No. 2. An elementary molecule means a little mass, or particle of elementary metal of two or more atoms, but smaller than a granule. Physical and chemical molecules are given in several subdivisions in this paper.

No. 3. A physical molecule is the smallest part into which a compound or two or more metals can be divided without changing its physical characteristics and constitution. Two or more of said molecules in physical union would be a complex molecule.

Note.—Amalgam alloy and amalgam molecules and amalgam alloy and amalgam granules defined. An amalgam alloy molecule is a particle of elementary metal of two or more atoms, or a compound of said metals, small enough to body crystalize together with mercury in an amalgam mass, and smaller than one 2,500th of an inch, average dimensions. Particles of said metals larger than one 2,500th of an inch are amalgam alloy granules. Alloy granules do not form in crystals with mercury, but surface crystallize together in the amalgam filling. In chemical union with mercury, the amalgam alloy molecule becomes an amalgam molecule, and the amalgam alloy granule becomes

an amalgam granule in amalgam fillings. See "Amalgam Crystallization," succeeding paragraph.

No. 4. A chemical molecule is the smallest part into which a chemical mass can be divided without changing its chemical constitution. A single atom of mercury chemically satisfied with atomic affinities such as gold, silver and zinc, or two or more atoms of mercury satisfied with said metals, the smallest that can exist in chemical union without changing the chemical relations, would be a molecule of dental amalgam. One atom of zinc in union with one atom of oxygen, makes one molecule of zinc oxid.

No. 5. A dental amalgam alloy consists of tin and silver with other metals, associated together or melted together and poured into ingot mass.

No. 6. A dental amalgam consists of Amalgam Alloy Filings, granules, or shavings mixed with mercury.

No. 7. Cohesion is a physical force which holds together atoms or matter of the same kind.

No. 8. Adhesion is a physical force which holds together atoms or matter of different kinds.

No. 9. Chemical adhesion or chemism is a force which holds together atoms or molecules of different kinds in crystalline chemical union.

No. 10. A "point" means one 10,000th of an inch, a unit of measure used to designate bulk change movements in Amalgam Fillings.

No. 11. Setting bulk changes in Amalgam Fillings are those which take place within twenty-four to forty-eight hours from time of packing the amalgam.

No. 12. Structural bulk changes are those which take place within one to five years or more, after packing the Amalgam Filling. These changes result from body crystallization and effect the internal constitution of the Amalgam mass.

No. 13. Crystallization in the Amalgam Filling means that mercury with gold, silver and zinc forms in crystals. It is either body or surface.

No. 14. Body crystallization means that the masses of gold, silver and zinc are atomic or so near to atomic, diminutive or small that the atoms or particles or molecules all form into crystalline structure, that is, the whole mass becomes a crystalline body; hence, body crystallization.

No. 15. Surface crystallization means that the molecules, particles or granules of gold, silver and zinc are so large that they will not form in crystals with mercury, but that their outside surfaces will surface crystallize together. No crystals form. The Amalgam becomes a concrete mass, because the silver units are too large for crystal formation. They make a hard, durable mass. Concrete work is a plain example of surface crystallization. Sand, pebbles and stone chippings mixed with Portland Cement, and water surface crystallize together into a hard, durable mass. Crushed stone in the roadbed is another example of surface crystallization. The sand, stone chippings and pebbles are not pulverized because such physics would cause body crystallization and make bad concrete. Crushed stone reduced to flour fineness in a roadbed would, for the same reasons, make a bad foundation. It would lack strength and durability. Please observe these distinctions.

No. 16. With a fine file cut 60 grs. of filings, from a U. S. Silver Coin. Mix with mercury enough to amalgamate. Press out all surplus which can be, through napkin, cloth or chamois. The resultant amalgam mass will weigh about 150 grains, more or less. Extreme pressure may reduce the mercury to 143 or 145 grains; 60 grs. of the filings in their inter-filing spaces therefore will hold about 90 grs. of mercury, more or less. Coin silver has a specific gravity of 10.2; mercury 13.6. Mercury is 1-3 times, or 33 1-3 per cent heavier, more in specific gravity than Coin Silver Filings.

No. 17. Mix 100 grains of tin with mercury enough for plasticity. The specific gravity of tin is 7.3, mercury 13.6. Press out the surplus mercury through napkin or chamois, all that can be. Specific gravity of the tin-mercury mass shows that mercury has caused decreased tin bulk to the extent of 0.65 of a gravity unit. The mass will weigh about 250 grains, which shows that tin requires 150 per cent of mercury for amalgamation; that is, 100 grains of tin and 150 grains of mercury. Tin-mercury mass remains soft and plastic indefinitely. It has a specific gravity of 9.2.

No. 18. Mix 100 grains of zinc with enough mercury for plasticity. Press out surplus through a napkin or chamois. The result will show that zinc has an increased bulk, and decreased specific gravity equal to 1,565 gravity units, below an equalized average. Mixtures of zinc and mercury always show increased bulk.

No. 19. Go to the gold beater, have him beat 100 grains of silver into foil one 10,000th of an inch thick. Mix with mercury quantity sufficient for plasticity. Press out the surplus through napkin cloth or chamois. It sets at once and with some heat. It will be found that the 100 grains of silver foil will require about 540 grains of mercury for full crystallization and amalgamation. Gold, similarly treated will require 390 grains of mercury to amalgamate 100 grains of gold foil, with specific gravity changes accordingly. These experiments show the

necessity of a classification of the gold and silver molecular constitution of Amalgam Alloys and Amalgams, because of large mercury requirements. Bear in mind that 100 grains of Crucible Melt Amalgam Alloy demands about 140 grains of mercury. Most makers advertise 5 parts of Alloy to 7 parts of Mercury. Too much. Right and logical percentages would be about 5 parts of Alloy to 3¾ parts of mercury.

No. 20. Sprinkle globules of mercury on a sheet of pure silver, one 1,000th of an inch. Watch. They will not percolate through in three months.

No. 21. Sprinkle globules of mercury on a sheet of coin silver (copper 1, silver 9 parts), same thickness. They will not percolate through in a year.

No. 22. Sprinkle globules of mercury on a sheet of any Crucible Melt Alloy, one 1,000th of an inch thick. Because of the tin in such alloy, they will percolate within a few minutes to a few hours.

No. 23. Sprinkle globules of mercury on an ingot of Amalgam Alloy, anybody's make. They will percolate into it within a few hours. The hardest alloy the writer has tested did not resist absorption more than a few days. An ingot of pure silver will resist large mercury globules several months. Coin silver for years.

No. 24. Surface coat a square inch of silver one 1,000th of an inch thick, with mercury; then wipe off all that can be with felt cloth. It will have an increased weight, about 1¾ grs. more or less. This experiment shows that each square inch of silver superficies requires about ⅞ gr. of mercury for surface physical and chemical affinities.

No. 25. Mix Silver Filings, Coin Silver Filings, and anybody's Amalgam Filings with mercury to sloppy saturation, say 5 parts of mercury to one part filings, each in separate bottles. Allow to stand and digest. Silver filings will be over one year losing granular plasticity. Coin silver filings several years. A Crucible Melt 60 Per Cent Silver, 40 Per Cent Tin Amalgam, will lose granular plasticity within a few hours or days.

No. 26. Fill a 2-inch cubic space with different sizes of bird shot, with diameters respectively ⅛, 1-12 and 1-16 inches, equal parts by weight, or with each separately. How much of said cubic capacity will be open, or inter-globular space?

Answers.

No. 27. Pack a 2-inch cubic space with silver filings, or Alloy Filings or granules, cut same as for Amalgam Alloy. How much open inter-granular, or inter-filing space?

Anwser.......48.60 per cent

NOTE. These open spaces correspond to the inter-molecular or inter-granular spaces between the molecules or granules of silver in Amalgam Fillings. These spaces should be filled with Tin-Mercury, having all surplus mercury, as near as can be, worked out in the packing process, and exactly fill, no more nor no less, because much more, or much less, would cause shrinkage, expansion, or crevicing and black ditches.

Molecular and Granular Alloys and

Amalgams Defined.

No. 28. Molecular Alloys are those in which the attenuated subdivisions of silver in the amalgam alloy mass are such that the silver particles (molecules) are smaller than one 2,500th of an inch (about). Molecular Alloys mixed with mercury make molecular amalgams. They .body crystallize and form in amalgam crystals with mercury.

No. 29. Granular Alloys are those in which the attenuation is such that the silver particles (granules) will be larger than one 2,500th of an inch (about). Mixed with mercury they become Amalgam granules in the Amalgam Filling. Silver, or compound silver granules are too large to form in crystals with mercury, hence they surface crystallize together with mercury. Because of size, these granules are not within the zone of crystallogenic attraction; hence, they do not form in crystals.

No. 30. Molecular-Granular Alloys are those in which the melting and cooling conditions are such as to cause both molecular and granular formation in the amalgam alloy mass, say about half and half each, more or less. A molecular-granular alloy contains large silver molecules and small silver granules, sizes, average dimensions, about, as aforementioned. Mixed with mercury they make molecular-granular amalgams.

AMALGAM ALLOY METALS. Gold, silver, tin, zinc and copper are the leading amalgam alloy metals. Other metals are frequently used, such as platinum, nickel, bismuth, cadmium, aluminum, antimony, iridium, cobalt, asenicum, and tellurium.

FOUNDATION PRINCIPLES AND GOVERNING LAW.

The following fixed and unchangeable laws control and govern amalgam alloys and amalgams:

LAW OF FORCES. There are three forces and two affinities which hold together the structure of amalgam fillings, and give to them their physical and chemical integrities. They are as follows:

FORCES. Cohesion, Adhesion and Chemism. The affinities are physical and chemical. All of these forces and affinities are manifested in amalgam alloys and amalgams, as will be shown in this paper:

LAW OF TRANSMISSION. That the physical properties of amalgam alloy metals are transmitted to the amalgam alloy ingot in which they are made component parts. That the physical, chemical and amalgam properties of mercury and of the amalgam alloy ingot filings or shavings are carried into the amalgam filling.

BULK CHANGE LAWS. That structural bulk changes in amalgam fillings are caused by the physical and chemical action of mercury on undissolved and uncrystallized amalgam alloy structure; that is, the action of mercury on amalgam alloy structure (atoms, molecules, or granules), which has not been reached by that metal during kneading and mortar grinding processes.

CLASSES AMALGAM ALLOYS. They are known as Crucible Melt Alloys, Coated Granular Alloys, and Partial Coated Molecular-Granular Alloys.

CRUCIBLE MELT ALLOYS. How to make them: Silver and tin are their basic metals, to which one or more of the metals aforementioned may be added, generally in small percentage. Silver may be first melted in the crucible, to which the tin may be added and stirred until they are thoroughly intermixed; or the tin may be melted in which granulated silver or silver in small pieces and other metals may be gradually melted. Some manufacturers place all metals in a crucible at one time and fuse together. Others melt the low fusion metals together in one crucible and the high fusion metals in another. These metals are then poured from one crucible to another until they are thoroughly intermixed. After the metals are thoroughly melted and intermixed, they are then poured into ingot, cooled and ready for cutting into filings or shavings.

This crucible melt method results in a conglomeration or mis-

cellaneous intermixture of the metals, atom to atom, molecule to molecule, or granule to granule throughout the amalgam alloy mass. All amalgam alloys for sale on the market, with but a single exception (Hewett's), are made by crucible melt method.

CLASSIFICATION, CRUCIBLE MELT ALLOYS AND AMALGAMS. All crucible melt alloys, according to the melting or dissolving heat and slow or quick cooling, and amalgam fillings made with them, have a varying molecular, physical constitution; different sized molecules of silver (classification) large, small or medium, and consequent varying harmful shrinkage, expansion, spheroiding, crevicing and sloughing of margins. High heat and too quick cooling causes small molecules, resulting in quick setting, expansion and crevicing. Slow cooling causes large silver molecules, slow setting and with excess tin and mercury tendency to shrinkage. Medium cooling gives medium sized molecules, medium setting and least shrinkage or expansion and crevicing. A classified physics and chemistry with mercury determine these movements. The molecular and granular constitution of the alloy determines the molecular and granular constitution in amalgam fillings. This classification determines the specific causes of the various harmful marginal and structural changes, resulting from wrong methods of making, and suggests or enables remedial conditions.

CRUCIBLE MELT METHOD WRONG. The crucible melt method of making amalgam alloys and cooling processes are wrong, because they give rise to a molecular structure in the amalgam alloy and amalgam fillings with defective properties as before named. These wrong physics and chemistry result as follows:

Heat is the repulsive force of metals, both of cohesion and adhesion. It insinuates itself between their atoms or molecules, drives them asunder and enables them to move freely among each other, in melted solution.

Cold is the attractive force in metals, both of cohesion and adhesion. As the melted mass cools, its atoms and molecules are attracted to each other and the liquid melted metals become a solid mass.

These repulsive and attractive forces act together at the same time in metallic masses. Apply heat to an ingot of silver, or tin. Its repulsive forces will drive the atoms or molecules further and further apart, while at the same time the attractive force is tending to pull them together. At length when the repulsive is equal or nearly equal to the attractive force, the atoms are free to move about each other, according to gravity. The metal becomes a liquid. If the heat is sufficiently increased in force, its atoms will be forced apart. If remote from each other, they will combine with oxygen of the air and form metallic oxids. Tin would be dissipated in the form of tin oxid. Zinc would become Zinc Oxid. Silver and gold in masses do not form into oxids by crucible heat.

Heat, therefore, gives three forms

of matter to all metals, viz.: Solid, liquid and gaseous or vaporous. When the attractive is much greater than the repulsive force, they are solid, when about equal, liquid, and when the repulsive exceeds the attractive, in ordinary metals, they become gaseous. These thermal relations and physical conditions are given that the student may gain a reasoning understanding of the molecular and granular constitution of Amalgam Alloys and Amalgams.

In making Crucible Melt Alloys, the molecular condition or classification of alloy masses depends upon the high heat and quick or slow cooling. If tin, silver, copper and zinc, the usual proportions, are melted in a crucible and the heat is raised to about 2,300 deg., or white heat, boil metal temperature, the crystals or masses of silver will be so highly subdivided or attenuated in the melted tin solution that they will become near to atomic and of a size equal to about one 10,000th of an inch: a size equal to the thickness of silver and gold foils given in physical experiment No. 19.

COOLING PHYSICS. When the melted metals used in making Amalgam Alloys are poured into ingot, the atoms and molecules of gold, silver and zinc have a physical attraction for each other. They pull together in little masses or larger molecules, in various centers during the congealing process. If the cooling is very quick or sudden, there will be no time for the molecules to pull together. They will be fixed in position at once, before attracting together in larger masses. The physical molecular and granular constitution at the time of pouring will be secured for the Amalgam Alloy when cold.

If the melted metals are poured into a hot matrix, say at about 1,000 degrees, or a dull red heat: then the melted mass will congeal slowly, during which the attenuated molecules of silver, say at about 1,900 to 2,300 deg. Fahr. at time of pouring and sizes about one 7,500th to 10,000th of an inch will have more time to attract each other in the melted tin. They will pull together in large molecules or granules of silver, or silver zinc, or silver-copper-zinc molecules. It is these high or low heat conditions and quick or slow cooling which give different degrees of attenuation and sizes of high fusion metal molecules and granules in Amalgam Alloys.

These molecules at very high heat are surrounded on all sides and all over with Tin. When they pull together in the melted tin mass, they become complex, that is, several molecules united in one. These complex molecules, therefore, are made up of many small molecules, forming the larger molecules or granules. The smaller molecules which make up the larger molecules or granules will still, in part or entirely, be surrounded by tin, and welded together by that metal in the larger molecules or granules. It is the action of mercury on this class of complex molecules, undissolved by mercury in the kneading and grinding processes, which cause harmful bulk changes in Amalgam Fillings years, it may be, after packed in the tooth cavity.

High heat and quick cooled Amalgam Alloys are very deleterious and apt to give bad results in Amalgam Fillings, because they require large percentages of mercury and body crystallize. (See Experiment No. 14.) The high heat attenuated silver molecules in high heat and quick cooled alloys require large percentages of mercury on the same principle that silver foils, say from one 5,000th to one 10,000th of an inch in thickness, require large percentages of mercury, because of their crystal forming nature. See Physical and Chemical Experiment No. 19. Thinness or minuteness of division is the cause of the large demand for mercury. High heat and quick cooled alloys make amalgam Fillings with much more harmful bulk changes and sloughing of margins, than high heat and slow cooled Alloys. Even the latter generally give bad results because the tin which welds simple molecules together in the complex will not be dissolved completely by mercury, in the kneading and grinding processes. Mercury continues to act years later on undissolved and uncrystallized alloy, after packed in the Amalgam Filling, and causes structural changes.

HARMFUL BULK CHANGES. Bulk changes in the Amalgam Fillings made with crucible Melt Alloys, no matter who may be the maker, are so extensive as to give bad results. These movements range from a few to 300 points and more in any Amalgam filling made with them. The writer does not believe that any average size or large Amalgam Filling, made with a Crucible Melt Alloy, was ever inserted, which bulk changed less than a few points within a few years. Many of them change, especially larger sizes, to as many as 300 to 500 points. These extensive changes are harmful and result in shrinkage, expansion, crevicing, spheroiding, breaking down of margins and black ditches. Leakage and recurrent decay result.

POURING HEAT IMPORTANT. The temperature at which melted Amalgam Alloys are poured into ingot determine the molecular constitution of the silver, gold, zinc and other metals in same. The lower the

heat, the slower the cooling, the larger will be the molecules and better results accordingly, right percentages of tin. Excess tin means shrinkage. Melted tin is a menstruum or excipient in which the molecules of silver, gold, zinc and other metals are held in solution, like common salt dissolved in water.

VARYING MOLECULAR STRUCTURE. Crucible Melt Amalgam Alloys always have a varying molecular constitution. They are cooled by pouring into an iron matrix. The outside part of the melted mass next to the matrix in the cooling process congeals first, cools much quicker than the inside part of the melted mass because the low temperature of the matrix immediately transmits its cold to the metals in immediate contact. The outside section of Amalgam Alloy ingot has a higher heat attenuated molecular silver structure than the inside, which cools more slowly, according to slower and quicker cooling relations. Amalgam Fillings made with alloys cut from the outside part of ingot will set quicker and with more harmful results than alloys made from the inside part of ingot. Therefore, all of such ingots should be cut into filings or shavings, then thoroughly intermixed and annealed before use. The molecules in the outside portion of the alloy ingot will be small, according to the degree of heat at the time of pouring and quick cooling. The molecules of the center section of the ingot will be large and complex, because the slow cooling allows time for attracting and pulling together.

LOST PHYSICS. The exact physical identities of the metals in alloys made by the Crucible melt method are lost in the melting and cooling conditions. There is only theory as to the atomic, molecular, granular and physical conditions in Amalgam Alloys made by fusing all of the metals together. They assume physical and crystalline arrangements, which no human mind can comprehend. The action of mercury in Amalgam Fillings made with filings cut from such alloys, vary when cut from different sections of the same ingot, according as their molecular and physical conditions vary. They vary in different batches, according as melting heat and cooling varies. There is only theory as to the action of mercury and harmful bulk changes in Amalgam Fillings, made with Alloys having Lost Physics. There is no way to test them, except by practical use in the mouth. Almighty difficult. Tested and "Original and Tested Alloys" are humbugs.

SILVER. This metal has dual bulk change properties, either expansion or contraction in Amalgam Fillings, according to its physical relations with tin and molecular and granular conditions in the alloy ingot. Go to the gold beater and have him beat pure silver into leaves of the following fractions of an inch thick, respectively: one 2,500th, one 5,000th, one 7,500th, and one 10,000th. Mix with mercury sufficient quantity to amalgamate. They take up respectively about 140, 255, 365, and 540 per cent of their own weight of mercury; 100 grains of gold in leaves, one 10,000th of an inch thick, require 390 grains of mercury to amalgamate.

In high heat attenuated molecular division, Silver-Tin Alloys with mercury increase in bulk. In large molecules or filings of any kind imbedded in surplus tin and mercury, the molecules or filings with eventually pull together. The Amalgam mass shrinks. These expanding and contracting properties are known as the dual bulk change properties of silver.

GOLD. Gold has similar dual bulk change properties in Amalgam masses; but is much more active because of its higher affinities for mercury.

TIN AND MERCURY PERCENTAGES. Referring to preceding cubic measure experiment No. 27, it will be noticed that the open or inter-granular molecular space is 48.60 per cent of the space occupied by the filings, packed tight in said space; 51.40 per cent of the space is occupied by the granules or filings and the space between the filings is 48.60 per cent of the whole space—total 100 per cent. This 48.60 per cent space must be exactly filled with tin-mercury amalgam, no more nor no less. Either much more or much less means ultimate harmful expansion, followed by shrinkage, years later.

Tin-mercury amalgam has a specific gravity of 9.2, near the specific gravity of silver; that is, silver has 1.33 per cent more gravity units in weight than tin-mercury amalgam. Tin and silver have specific gravities respectively 7.3 and 10.53. Mercury is nearly twice as heavy as tin, specific gravities, respectively, 13.6 and 7.3. Therefore, the space between the molecules, filings or granules of alloy, 48.60 per cent, will require an equal bulk of tin-mercury mass to fill in between. But the tin-mercury mass is 15 per cent lighter than silver, which is always the main and preponderating bulk in amalgam alloys. If the inter-granular space between the filings is 48.60 per cent of the whole space, the filings will occupy 51.40 per cent of the whole space. If 100 grains, packed tight, occupy 51.40 per cent of a given space, 1 per cent of the space, therefore, will be occupied by 1.945 grains,

and 48.60 per cent open space would require 94.527 grains of the same specific gravity. The 94.527 grains is 920-1,053rds of the number of grains necessary to fill in between the inter-granular space, because the tin-mercury mass is exactly 920-1,053rds as heavy as silver; 920-1,053rds of 94.527 grains is 82.58 grains. A test tube packed full with 100 grains of silver filings, specific gravity 10.53, would occupy 51.40 per cent of space in said tube. The open space between the filings, 48.60 per cent of whole space, would require 82.53 grains of tin-mercury mass, having a specific gravity of 9.2 to completely fill in between.

This tin-mercury mass contains 2 parts tin, and 3 parts of mercury. See foregoing experiment No. 17. Five parts in all. One part, therefore, would be 16.51, two parts 33.02, and three parts 49.53 grains; 100 grains of filings or granules of molecular silver alloy, therefore, would have 33.02 grains of tin as a logical quantity, which, with the silver granules, would make the total weight of the Amalgam Alloy 133.02 grains, of which 33.02 grains of tin is 24.83 per cent. But preparing and packing processes will not express the mercury from the tin-silver Alloy, any kind, so that there will be no excess of that metal. Mercury has such a high physical affinity for tin and chemical affinity for silver, that great pressure, more than the dentist can exert, would have to be used to remove all excess. Best that can be done, about 10 per cent surplus will remain. The logical percentage of tin, therefore, to associate with Amalgam Alloy, is 24.83 per cent, near 25 per cent. The right percentage would be about 27 per cent of tin, the 2 per cent surplus tin to associate with and somewhat satisfy the excess mercury, which must always remain in the amalgam filling.

PHYSICAL AND CHEMICAL EXPERIMENT No. 24 shows that 1 square inch surface of silver will hold in surface physical and chemical affinity, after swiping off all that can be, with felt cloth, about ⅞ of a grain of mercury. Ordinary sized Amalgam Alloy Filings, per Troy ounce, have about 200 square inches superficies. Silver molecules in them require a certain percentage of mercury for physical surface affinity and surface crystallization. The 33.02 grains of tin associated with 100 grains of silver granules or filings require about 49.53 grains of mercury to amalgamate. The excess mercury which cannot be pressed out will be about 10 per cent of the whole weight of the alloy; 100 grains of silver units in an alloy mass will have about 40 inches of superficies. Each square inch silver surface demands ⅞ of a grain of mercury. Forty square inches would require 35 grains of mercury to satisfy surface physical and chemical attraction. The tin with the 100 grains of filings, 133.02 grains in all, demand 100 grains of mercury for physical and chemical affinities and surplus mercury in the amalgam mass. The 33.02 grains of tin, on the basis of 2 parts of tin to 3 parts of mercury, requires 49.52 grains of mercury to satisfy its physical affinity. The surplus mercury which always remains because of inability to remove, constitutes another 10 per cent of the total weight of the alloy; 10 per cent of 133 grains is 13 grains, which with the 49.52 grains of mercury with the tin and 35 grains of mercury with silver surface affinity, make 97.52 grains in all. Therefore, 97 grains of mercury to 133 grains of Alloy is near to a right percentage to remain in Amalgam Fillings, made with Amalgam Alloys compounded by true scientific method.

These experiments show that an Amalgam Alloy properly compounded, mixed with mercury and packed in the tooth cavity should retain with it only about three-fourths of its own weight of mercury; three-fourths of 133 is 99.27. There will be very little more or very llittle less after all has been pressed out which can be in the expressing and packing processes. The right ratio, therefore, of alloy and mercury is 5 parts of alloy to 3¾ parts of mercury in the amalgam filling, say 20 grains of alloy to 15 grains of mercury. Amalgam Fillings prepared with Crucible Melt Alloys, as advertised by their makers (see foregoing), require 5 parts of alloy to 7 and 7½ parts of mercury. Some makers advertise 5 parts of alloy to 8 parts of mercury.

BAD PHYSICS AND EXCESS MERCURY are the causes of all harmful shrinkage, expansion, spheroiding, crevicing, loss of strength and black ditches in the Amalgam Fillings. The varying physical molecular constitution of the alloy, acted upon by the mercury element in excess, gives rise to specific causes and movements. One kind of molecular structure will cause the Amalgam Filling to shrink, another to expand, another to spheroid and crevice, another to black ditch, etc. Amalgam Fillings, made with alloys which retain their own weight and more of mercury when packed should be condemned at once. They will lose about two-thirds of their crushing resistance and marginal strength inside of two years from the time of insertion. About two-thirds to three-fourths of them will ultimately black ditch and crevice, so as to be seen with the naked eye.

AMALGAM SHRINKAGE. Large size silver molecules with excess tin or mercury surrounding them will shrink, because of the chemical attraction which they have for each other in the excess menstruum. They are not fitted close together with just enough tin-mercury mass to fill in between their inter-molecular or inter-granular spaces. If fitted closely together with no excess tin or mercury between, they could not shrink for the reason that there would be no shrinkage space between them. They may be compared to birdshot cubic measure experiment No. 26. Said measure will hold a certain weight and number of said shot with open spaces between. Melted vaseline poured on them will flow and fill in between their inter-globular spaces. These globular units cannot shrink nor pull further together in the vaseline mass, because they are already closely fitted against each other. There is no shrinkage space. If said birdshot were mixed with double the quantity of vaseline surrounding them so that in many places throughout the mass they would not touch each other, they would ultimately shrink and pull together, if they have an attraction or affinity for each other. Gravity alone would cause them to settle together in melted vaseline.

This birdshot experiment gives a plain illustration of the movements which may take place in Amalgam Fillings, made with low heat, large size silver molecules alloy with excess tin and consequent excess of mercury in Amalgam Fillings. The mercury and the excess tin causes these molecules or granules to have chemical attraction for each other. They pull together with strong chemical action. It is slow, but certain and sure. Excess tin and mercury in the Amalgam Fillings of this class make ultimate shrinkage, as certain as the law of gravitation. If there is no excess tin-mercury, and the molecules or granules are fitted close together in packing the Amalgam Fillings, there will be little or no shrinkage, depending upon an exact fitting of the parts together by physical and chemical process.

AMALGAM EXPANSION. High heat, attenuated silver molecular alloy is the fundamental and main cause of expansion in Amalgam Fillings. Such molecules are very small, and of varying sizes, according to high heat and slow or quick cooling conditions. The minuteness of division causes them to have a ready affinity for mercury. Even when kneaded in the hands, the rapidity of chemical action will cause perceptible heat. The minuteness of division causes a rapid formation of crystals and the absorption of large percentages of mercury. See Physical and Chemical Experiment No. 19. Crystal formation always results from the chemical union of silver and mercury, attended with enlargement (specific gravity decrease). Highest heat and sudden cooling would cause a demand for very large mercury percentages.

During the process of kneading in the hand and grinding in a mortar, mercury does not reach all of the molecular granules in high heat molecular alloys, nor all of the tin between them and which welds them together. Therefore, there is no complete molecular solution. The mercury has not reached all of the atoms, molecules or granules, and the tin between them possible for it to reach, and for which it has physical and chemical affinities. After the amalgam is packed in the tooth cavity, the mercury will continue to act in the amalgam mass. It will be attracted by the metals, such as tin, silver and zinc, which were not reached by it during the kneading and grinding process. In high heat molecular conditions these affinities would be very active, and result in crystalline expansion. The amalgam filling enlarges. If free to move outward it will protrude. If free to

move out on one side only, and not on the other, the Amalgam Filling will tilt.

SPHEROIDING AMALGAM. If the Amalgam Filling is made with undercuts or retention grooves, or of such shape that it is not free to move outward, or the friction along the cavity wall is such that there is no freedom of movement, it will spheroid if made with high heat, attenuated molecular alloy. The diminutive molecules of silver in the alloy mass causes rapid crystallization and expansion. The amalgam mass presses out in all directions. It can move only in the direction of cavity orifice. It cannot move outward along the margin because of the friction and retaining grooves; hence, it will bulge out at the center like freezing ice confined in a bucket. It becomes oviform, spheroidal. It swells up and out.

CREVICING AMALGAM. Crevicing along the margins of Amalgam Fillings is a movement which follows expansion. It always results, and may be either microscopic or visual. When the movement is extensive it can be readily seen with the naked eye. After the internal compression resulting in expansion and spheroiding ceases, the amalgam mass continues to press against the bottom and walls of the cavity. The counter action which takes place in the relief of the compression, and the physical and chemical affinities of the silver molecules for each other in the amalgam mass, produces a counter crevicing movement. Open spaces occur along one margin and corner of the cavity, or it may be along all sides of the cavity, but generally along one or two sides and corners only. Freezing ice confined in a vessel, bulging out at the center and finally relieving along the sides, are plain examples of spheroiding, expansion and crevicing of Amalgam Fillings.

AMALGAM CRYSTALLIZATION. Crystallization in amalgam fillings means that mercury with gold, silver and zinc, or some other metals form in crystals. It is either body or surface. See foregoing physical and chemical experiments Nos. 13, 14 and 15.

ZONE LINE OF DEMARKATION BETWEEN SURFACE AND BODY CRYSTALLIZATION. According to physical and chemical experiments in classified molecular and granular alloys, it is shown that silver or silver compound molecules, granules, filings or particles, smaller than one 2,500th of an inch (about) will body crystallize together with mercury in amalgam fillings. Larger than one 2,500th of an inch (about) will surface crystallize together.

CRYSTALS WITHIN CRYSTALS.—The elementary amalgam alloy metals are masses of crystals. When compounded by melting together and poured into ingot, they form into crystals during the cooling process. An amalgam alloy ingot, therefore is a mass of compound crystals. The particles, filings or shavings, into which they are cut also are masses of compound crystals. If, when they are mixed with mercury, the tin surrounding them is dissolved, and they are small enough for body crystallization, the alloy molecules, composed of microscopic crystals, will form into amalgam crystals with mercury; hence crystal alloy molecules forming into crystals with mercury, will result into a formation of crystals within crystals; that is, crystal alloy metals will form into amalgam crystals with the metal mercury. If the silver units in the filings, particles or shavings

are so large as to be outside the zone of body crystallization, they are called granules and do not form in crystals, but surface crystallize together and make a concrete mass. The former constitute molecular and the latter granular amalgam alloys and amalgams.

SERIES OF PROVING EXPERIMENTS, WHICH INDICATE SPECIFIC CAUSES, BULK CHANGE LAWS, AND RECENTLY DISCOVERED PROPERTIES, WHICH CONTROL AND GOVERN AMALGAM ALLOYS AND AMALGAM FILLINGS.

See series of eight proving experiments in Keller's Amalgam Principia, page 13.

PROVING EXPERIMENT No. 1.—Place three ounces of silver and two ounces of tin in a crucible; melt. When at a bright red heat (incandescent red), about the melting point of silver, pour out about one-half of the contents on a cold iron slab, or in a large iron matrix, so as to cool the mass suddenly. Allow the other half to remain in the crucible and cool slowly in and with the crucible itself.

HIGH HEAT INGOT.—Amalgam masses made with filings, cut from the quickly cooled ingot, will be quick setting, have outrageous expansion, from 200 to 1,000 points, to each 60 grains of alloy used. Amalgam fillings made with such alloys will spheroid, protrude, or tilt, followed by crevicing at one side or corner. Such alloys make what may be designated as high heat attenuated silver-amalgam fillings.

LOW HEAT INGOT.—Amalgam fillings made with filings cut from the slow cooling ingot, will begin to shrink as soon as packed in the tooth cavity. The movement will be from a few to 300 points or more to each 60 grains of alloy used. They may be designated as Low Heat Attenuated Silver Amalgam Fillings.

Give the physical, molecular and chemical causes of the foregoing bulk change conditions in Proving Experiment No. 1.

PROVING EXPERIMENT NO. 2.—Melt 60 ounces of silver in a crucible and add tin, quantity sufficient to make 100 ounces. When at a red heat pour into an iron matrix. The outside section, near to matrix will cool very quickly, and the inside section of metal will cool slowly. Amalgam fillings made with filings cut from outside section of silver-tin ingot will expand at the rate of 25 to 200 points or more to each 60 grains of alloy used; and from the filings cut from

inside section near the center of ingot, will shrink at the rate of 25 to 100 points, accordingly.

Give the physical, molecular and chemical causes of bulk change movements in Proving Experiment No. 2.

PROVING EXPERIMENT NO. 3.—Repeat No. 1 experiment, adding 2 per cent of zinc amalgam fillings made with filings cut from the high heat, quick cooling ingot, will have very extensive expansion from a few hundred to 1,200 points or more, to each 60 grains of alloy used. Cuttings from the low heat ingot will make amalgam fillings which will have slight expansion only, followed by slight tin shrinkage. Silver shrinkage is somewhat offset with zinc enlargement.

Give the physical and chemical causes of bulk change movements in Experiment No. 3.

LOST STRENGTH AND BLACK DITCHES. Amalgam Fillings made with Crucible Melt Alloys lose about two-thirds of their highest crushing resistance and marginal strength inside of two years from the time of insertion; hence, almost universal ultimate bulk change and breaking down of margins, resulting in black ditches and tendencies to recurrent decay. **SPECIFIC CAUSES:** Loss of strength, sloughing of margins and black ditches are caused by extreme structural changes in the Amalgam Filling (quick setting alloys worst). Such changes result from high heat attenuated silver or zinc molecular constitution in the alloy, either or both, and which determine the molecular constitution of the amalgam. The action of mercury on undissolved and uncrystallized alloys are the immediate basic physical and chemical causes. For a full scientific discussion of these causes, and of the atomic, molecular, granular. physical and chemical constitution of amalgam alloys and amalgams, the student is referred to Keller's Classic Researches in Amalgam Alloys and Amalgams.

MERCURY PERCENTAGES. The alloy in an Amalgam Filling, after packed, should not contain more than three-fourths of its own weight of mercury; that is, 24 grains of alloy and 18 grains of mercury in the filling. For mixing, kneading and grinding, 24 grains of alloy to 24 to 28 or even 30 grains or more of mercury may be used. Pressing out the surplus through napkin cloth, and in packing, should reduce the mercury quantity to about 18 grains to each 24 grains of alloy, if the alloy is made by true scientific method. By the crucible method, each 24 grains of alloy will require from 30 to 40 grains of mercury in the filling after packed. Too much. It is bad physics and excess mercury which causes loss of strength and harmful bulk changes in Amalgam Fillings. Bad physics demand excess mercury.

Any alloy which requires its own weight or more of mercury in the amalgam filling should be condemned, because its filling will be liable to ultimate harmful structural changes, such as shrinkage, expansion, crevicing and breaking down of margins. These are logical results and as certain as law. Alloys which require more than their own weight of mercury in the filling and which come within aforementioned high molecular conditions, and ultimate loss of strength, are discussed by Professor Marcus L. Ward, D. D. S., Detroit, Mich., in a paper, "Original Communication" in the February *Dental Cosmos,* 1908, and in part is as follows:

Dr. Ward says, *"As you are all aware, since 1895 and 1896 we have had furnished to us alloys commonly known as Black's Alloys, some of which are really made as he would like them, while others are only imitations. Twentieth Century, Fellowship, Triumph, Permaneo, Acme, Micrometric, Rego, True Dentalloy, and Superior, and any others which are composed of from 65 to 68 per cent of silver, 29 per cent to 28 per cent of tin, 3 per cent to 5 per cent of copper and 1 per cent to 2 1-2 per cent of zinc, fall into the class that we are now considering, though we must not consider all alloys which fall into this class through proper composition desirable ones to use, because shrinkage, expansion and strength are controlled by at least four things, viz: composition, fineness of communition, annealing and casting. Since this class of alloys are similar in composition and behavior, let us examine the mercury proportions advocated by their makers on the circular matter accompanying each package of alloys:*

MERCURY AND ALLOYS RESPECTIVELY.

	Parts.
Twentieth Century Circular says	7 to 5
Fellowship Circular says	7 to 5
Triumph Circular says	7 to 5
Permaneo Circular says	7 to 5
Acme Circular says	7 to 5
Micrometric Circular says	6 to 5
Rego Circular says	5 to 4
True Dentalloy Circular says	11 to 9

"If we now compare the smallest amount of mercury with the largest, we find that there is a difference of 5-43 of a grain for every grain of alloy used. In seeking an explanation, I must refer you to the work of Black, the author. Black advanced the theory that when an alloy had been cut into a convenient form for use, it must be heated a certain time at a certain temperature to make a product that would not be affected by the temperature that it would necessarily be subjected to by standing around. He also advanced the theory, since recognized as a fact, that with this heating, less mercury was required to make a plastic mass."

After discussing effect of excessive mercury upon various qualities in amalgam, Dr. Ward continues:

"On the 19th of January, 1908, I discussed before the Chicago Odontographic Society (see DENTAL REVIEW, *Vol. XXI, No. 4) some changes in the strength of alloys which appear to be unavoidable. About one year previous to that time I made two hundred fillings from our best alloys. They were made 1-8-inch in diameter and 1-8-inch high, and with the intention of developing about all of their strength. Six of these fillings were broken at one time with a dynamometer at varying intervals from that time up to the present. An average of the fillings thus broken was taken as the crushing resistance of the alloys at the time and was as follows:*

COMPOSITION PERCENTAGES.

Alloy No. 1	Per Cent	Alloy No. 2	Per Cent
Silver	68.00	Silver	65.50
Tin	26.50	Tin	25.50
Copper	4.20	Zinc	3.00
Zinc	1.30	Copper	6.00

CRUSHING RESISTANCE.

Age of Alloy	Alloy No. 1 Pounds	Alloy No. 2 Pounds
1 day	435	452
2 days	478	462
4 days	485	453
24 days	493	447
42 days	497	447
205 days	414	367
341 days	434	310
491 days	177	163

"The first thing for us to notice in this connection (foregoing table) is that a certain time is required for an alloy to reach its maximum strength. Second, that the period of maximum strength lasts but a short time, after which the alloy begins to deteriorate in strength. When we see the first alloy has a certain crushing resistance of 497 pounds, and in less than two years it had one of 187 pounds (nearly 2-3d loss), and that the second alloy, whose crushing resistance was 462 pounds, deteriorated to 163 pounds (nearly 2-3ds loss, lacking 9 pounds only), in the same time, are we not inclined

to ask—'is there a definite crushing resistance in this class of alloys?' The question becomes the more forcible when we consider that the alloy deteriorates before it is made into fillings, as well as afterwards."

The foregoing results, loss of strength, as determined by Professor Ward's scholarly and scientific experiments with amalgam cubes made with crucible melt alloys and consequent expansion, crevicing, breaking down of margins and black ditches, can be remedied only by making concrete alloys, with granules or filings so hard and tough, that under the conditions in the amalgam filling, mercury will neither eat, dissolve, nor penetrate them, but surface crystallize them together into a solid mass. As soon as the mercury forces for tin, silver and other metals become equalized, bulk changes cease. Concrete alloys require only ¾ of their own weight of mercury; crucible melt alloys, equal weight of mercury or more (7 parts of mercury to 5 parts of alloy, see table), and the following formulas and plans of construction will show how to make coated molecular and coated granular alloys. They are scientific methods, and

AMALGAM SCIENCE IN A NUTSHELL.—Formulas, methods of making, physics and chemistry and logical results are given. The physical identity and condition of the metals are maintained, so that both the dentist and the alloy maker can comprehend. In crucible melt alloys, physical identities are lost, hence Lost Physics. Neither dentist nor maker can know what the amalgam filling will do. It may either shrink, expand, or both spheroid and crevice. No way to test except by practical use in the mouth.

No. 1 ALLOY. FORMULA—Silver, 70.5 decimal parts; copper, 2.0, and nickel, 0.5. Fused within tin, 25.0 without intermixing. Cut and coat with zinc, 2.0 to maintain color.

Zinc coating, 2 per cent, contains 5 per cent gold (0.48 grain), q. s. to quickly mix.

Zinc melted with tin and other metals causes harmful expansion and final structural changes in Amalgam Fillings, according to percentage. By Kellers' Coating Method it is harmless. Right percentage, it is non-sulfiding, never discolors nor corrodes in any mouth. MERCURY. Use plenty, enough to make a plastic, but not sloppy mass. Knead in hand, then rigidly grind one minute in a wedgewood mortar. Press out surplus through napkin or chamois. Knead plastic again, then fill. Reduce mercury in packing as much as possible. Tin and mercury tend to cavity orifice and margins. When cavity is full, remove 1-32 to 1-64 of an inch, then replace with fresh alloy, not before used in packing, for maintenance of margins. PROPERTIES. No. 1 is a molecular-granular alloy, with compound silver molecular granules, sizes between one 1,500th and one 3,000th of an inch and coated with gold, tin and zinc; part molecules, mostly granules. It is compounded by fusing the metals in a crucible with cooling conditions, so as to but partially intermix the high and low fusion metals; hence, A MOLECULAR-GRANULAR ALLOY. Amalgam cylinders 3-16 by 3-16 made with it will have a standard crushing resistance of 1,200 pounds and margin strength accordingly. Are increases. Structural changes, that is, schrink, swell up, tilt, spheroid and crevice movements, average less than one-fourth as much in Amalgam Fillings made with best crucible melt alloys, which all change

from a few to 300 points or more, within one to five years after insertion. Silver molecules in No. 1 alloy are small enough for plasticity, but so large as to have but little or no body crystallization. They surface crystallize together into hard, stable amalgam mass. **ZINC COATING.** Each molecule, filing, granule or particle of alloy, either Nos. 1, 2, 3 or 4 in the Amalgam Filling, is coated with zinc to a thickness, more than one 20,000th of an inch, hence, they surpass all other alloys in whiteness and maintenance of color.

No. 2 ALLOY. FORMULAS. No. 2 alloy is a half and half mixture of Nos. 1 and 3, half coated molecular-granular No. 1 and half coated granular filings No. 3. By intermixture the working, physical and chemical properties of the alloys are somewhat blended and conserved. **MOLECULAR ALLOYS.** All crucible melt alloys, according to melting heat, and slow or quick cooling, and Amalgam Fillings made with them, have a varying molecular constitution, different sized molecules and consequent varying harmful bulk change movements. High heat and quick cooling causes small, attenuated molecules, expansion and crevicing. Slow cooling, with excess tin larger molecules and small granules (molecular-granular) and shrinkage, with excess tin and mercury. Medium cooling gives medium sized molecules and right formulas, least expansion and shrinkage. **REDUCE BULK CHANGE MOVEMENTS** by using Nos. 1, 2, 3 or 4, coated molecular and granular alloys made plastic by grinding in a wedgewood mortar. **BLACKS THE HAND.** Mercury releases tin protoxide, which blacks the hand, but not the filling. No harm. Sulfide makes filling black. **PROPERTIES.** No. 2 alloy is semi-molecular and semi-granular, half coated filings and half coated molecules; non-sulfiding, high retention of color and seldom corrodes. Standard crushing resistance, 1,200 pounds. Structural bulk changes, that is, shrink, swell up, and tilt, or spheroid and crevice movements average only about one-sixth as much in Amalgam Fillings, made with crucible melt alloys, which all change from a few to 300 points or more within one to five years after insertion. **DIRECTIONS.** Surplus mercury and tin will come to the surface in packing Amalgam Fillings, any alloy, and cause weak margins and black ditches. Make margins strong by removing about 1-64 to 1-32 of an inch when cavity is full. Refill with fresh amalgam, which has not been used in packing. **CONDEMN** alloy shavings. Harmful shrinkage and expansion result in fillings made with high per cent tin-alloys, which cuts into shavings.. **REMEDY.** Coated molecular-granular alloys, mortar ground. Filings or granules and molecules must be so hard and tough that under the physical and chemical relations in the Amalgam Filling, mercury will neither eat nor dissolve them.

No. 3. ALLOY. FORMULA. Silver, 97.5 ozs.; copper, 2 ozs.; nickel, 0.5 oz. (or copper-bronze, 2.5); total, 100 ozs., melted together, poured into ingot, then cut into very fine composition.

Silver Filings, 73 ozs. of which are coated with 25 ozs. of tin and 2 ozs. of zinc.

Zinc coating, 2 per cent, contains 5 per cent gold (0.48 gr.) q. s. to quickly mix.

PURE SILVER FILINGS, or **U. S. COIN SILVER FILINGS** (copper 1, silver 9 parts) may be successfully used, instead of above compound silver filings. **PROPERTIES.** Non-molecular, granular, all coated filings, gold, tin and zinc coating gives high retention of color; hence non-sulfiding, seldom, or never discolors nor corrodes in any mouth. Amalgam fillings made with No. 3 alloy has an initial expansion of a few points, tight against the cavity wall; hence no recurrent decay leakage. Standard crushing resistance, 1,200 pounds. No harmful structural bulk changes, that is, shrink, swell up, and tilt, or spheroid and crevice movement, are less than one-tenth as much as in amalgam fillings made with best crucible melt alloys, which all change for a few to 300 points or more within one to five years. **BULK CHANGES** are caused by the physical and chemical action of mercury in the amalgam filling, on alloy, not reached or dissolved by the kneading and mortar grinding processes. Therefore, thoroughly grind all alloys in a wedgewood mortar to reduce bulk change movements. **WEAK MARGINS.** Amalgam fillings made with crucible melt alloys lose about two-thirds of their strength inside of two years; hence, black ditches and recurrent decay. Granular "alloys" increase in strength and maintain margins. No black ditches. **DIRECTIONS:** Numbers 3 and 4 alloys require wedgewood (not glass or porcelain) mortar grinding, one minute or more, with a rigid cutting friction; 16 grains of coated granular alloys require only 12 grains of mercury in the filling; alloy, 5; mercury, 3¾ parts. Five parts of crucible melt alloys require 7½ parts of mercury; hence, marginal breakdown, black ditches and leakage. Observe that coated molecular-granular alloys require about half as much mercury in the filling as crucible melt alloys; hence, harmless shrinkage, expansion, crevicing and no black ditches.

NO. 4 ALLOY. FORMULA. Silver, 97.5 ozs.; copper, 2 ozs.; nickel, 0.5 oz. (or copper-bronze, 2.5 ozs.); total, 100 ozs., melted together, poured into ingot, then cut into very fine composition.

Silver filings, 73.00 ozs., of which are coated with 18.75 ozs. of tin and 6.75 ozs. of gold, and 1.50 ozs. of zinc.

Total coating, 27 per cent, contains 25 per cent gold, hence trademark name. Melting and inter-mixing high and low fusion metals together in a crucible is fundamental error and with excess mercury, cause of harmful shrinkage, expansion and crevicing in amalgam fillings. Granules or filings, so hard, tough and resistant that, under the physical and chemical conditions, mercury will not dissolve, but surface crystallize them together, are necessary to gain least and harmless contraction, expansion and crevicing and no black ditches. As soon as the physical force of mercury for tin equals its chemical surface crystallizing force for granules or filings, bulk changes cease. Equilibrium results. **PROPERTIES:** Gold and zinc coating, respectively, covering each filing, or granule, in the filling; one 10,000th to one 25,000th of an inch thick, give highest retention of color. Standard crushing resistance, 1,600 pounds. Properties, otherwise same as No. 3. **GOLD,** melted with high and low fusion metals, is a bad disturber. Amalgam fillings, made with gold crucible melt alloys, will not lie still. Its active chemical affinity for mercury hastens contraction, expansiou and crevicing. Gold coated granules or filings are harmless; add 25 per cent to marginal strength and crushing resistance and nearly doubles retention of color. **PHYSICS:** Nos. 3 and 4 formulas and plans of construction, maintain physical identities of the high fusion metals, coated with low fusion metals, gold, tin and zinc. **CHEMISTRY:** Mercury dissolves coating, making a chemical mortar, which surface crystallizes granules together into a hard amalgam. **LOGIC:** Mercury neither eats nor dissolves filings. Its physical and chemical affinities soon equalize; hence, harmless bulk changes.

NOTES—Number 1 gives formula for a partial process coated molecular alloy, compounded so as not to intermix the high and low fusion metals. The high fusion metals, such as silver, copper and nickel, are associated in granules and surrounded or coated with the low fusion metals, tin and zinc. Each silver-copper-nickel molecular granule in amalgam fillings made with alloys, either Nos. 1, 2, 3 or 4, is coated all over with zinc.

Number 2 described No. 2 alloy, a half-and-half mixture of numbers 1 and 3.

Number 3 gives formula, high fusion metals, melted together, cut into very fine filings, which are then coated with gold, tin and zinc. The metals, silver, copper and nickel, are associated together in the filings, the outside surfaces of which are coated. The dentist can know how the metals are arranged and can comprehend their physics and chemistry as well as the maker of the alloy. **LOGIC:** Mercury will neither dissolve nor eat these filings; hence, harmless bulk change and marginal conditions.

Number 4 gives formula same as 3, except 25 per cent gold coating. These sections are condensed briefly concerning the most profound physics, chemistry and logic in amalgam science. They condemn the crucible melt alloy and tell how to remedy it.

NO MYSTERY. Humbuggery amalgam alchemy and exploitation will continue until dentist knows formulas and such scientific methods of compounding alloys and cements, as will give physics, chemistry and logical results.

POURING AND FUSING PROCESSES.—It is not within the province of this paper to give the details of coating processes and melting high and low fusion metals together without intermixing these classes. Both processes can be successfully accomplished and are the basic principles for constructing coated granular and coated molecular-granular alloys. Without these coating processes, with gold, tin and zinc the whole system of concrete, granular, and classi-

fied molecular construction would be a failure. The foundation principles upon which amalgam alloys must be constructed, so as to gain least and harmless bulk changes best stability and highest retention of color are based upon these coating physics.

BEST STABILITY AND STRENGTH.—Fundamental Statement. Dentistry can never get amalgam fillings which will not move nor phosphate cements which will not dissolve. He who represents absolute stability and insolubility is a deceiver and a fraud. Even, *"expands one 20,000th of an inch"* is not a practical possibility—either bulk or structural

They are not problems of "No Movement," and "Insolubility," but harmless bulk changes and least solubility. Amalgam fillings made with crucible melt alloys all change from a few to 300 points or more within one to five years from time of insertion. The best stability and strength which can be gained with coated granular and coated molecular-granular alloys, probably, will be an expansion ranging from one to fifteen points and a standard crushing resistance of about 1,700 pounds. The latter obtains in 25 per cent gold coated granular alloys, amalgam made. Ultimate marginal strength and crushing force of crucible melt products will be about ¾ less, that is about ¼ as much. See quotations from Prof. M. L. Ward, Original Communication, 1908, February Dental *Cosmos,* preceding pages, as to loss of strength which result in amalgam fillings made with crucible melt alloys.

NEW SYSTEM ALLOYS.—At least four of the amalgam alloys named in Ward's foregoing table, *Twentieth Century, Fellowship, Rego* nad *True Dentalloy* are known as "new system alloys." They are made according to the Black system of formulas and annealing processes. They have been on the market about twelve years. Dr. Black's amalgam graduates compound them by the crucible melt method. Most of these graduates have advertised that amalgam fillings made with them "expand one 20,000th of an inch," thereby indicating stability of amalgam structure, accordingly. This advertising has been persistently followed ever since the inception of these alloys, to within the last few years. Practical experience in their use shows that they shrink, expand, spheroid, crevice and black ditch (some more, some less), same as other alloys, made during the same period and before. On the whole they are a betterment, which results mostly from Black's

formula, demanding larger silver percentages, ranging from 68 to 73, and his annealing process. Under the old system many alloys were made with 40 to 50 per cent silver, balance tin, with now and then a small percentage of copper, zinc and other metals. The large percentages of tin in alloys causes amalgam fillings made with them to be guilty of excessive shrinkage, or both expansion and shrinkage, or crevicing. These combined movements result from physical and chemical causes aforegiven. Since the advent of Black in the amalgam problem, Black's formulas (so-called) have demanded about 73 per cent high fusion metals.

BLACK ANNEALING PROCESS. New system alloys are made by Black's amalgam graduates, according to the crucible melt method, somewhat the same as compounded by others. After cut into filings or shavings, these alloys are annealed or aged by placing in a tin can with cover, then set in boiling water about fifteen minutes, or heated in an electric oven at 150 degrees for several hours. This annealing process was used to overcome or remedy a wrong method of manufacture. It but partially accomplished it. The fact that amalgam fillings made with new system alloys undergo structural bulk changes ranging from a few to 300 points or more, within one to five years after packed in the tooth cavity shows that the annealing process is a failure. At best it is only a betterment. The writer has filled large cavities in bone and ivory equal in size to large amalgam fillings with these alloys. Carried in the pocket or laid aside during the course of a few years, say three to five, some new system amalgam fillings would shrink or expand or crevice to the extent of 300 points. Some would move more, some would swell out 300 points and crevice 100 points, some more, some less. Bear in mind that these fillings were made with alloys prepared by Dr. Black's amalgam graduates, who advertised stability of structure to within "one 20,000th of an inch." Some few would have good stability. He is a dull and stupid dentist who has not read the special "ad." "one 20,000th of an inch."

ANNEALING PROCESS THEORY. The annealing process was theory with Dr. Black. He never classified the molecular constitution of amalgam alloys and amalgams so as to be able to give the physical and chemical causes of the annealing process which he discovered. In paragraph 2, page 309, Black's Operative Dentistry, Vol. 1, reads as follows:

"Conclusion—The cut alloy is made abnormally hard by the violence in cutting, the same as metals are made hard by hammering. By the process above detailed (that is, heating in boiling water 15 minutes, or at 150 degrees twelve hours), it becomes annealed to normal. The change was produced by heat. This effects a change in the affinity for mercury and the rapidity of combination, with the results named above. WHY, is unknown; but the fact stands all test. It is a primary physical phenomenon."

ANNEALING PROCESS, A FACT. The changes which take place by Dr. Black's annealing process in the foregoing paragraph are correct, but they may be readily taken from the domain of theory. Bear in mind that this annealing process is used to make fresh made and quick setting alloys, slow or slower setting. By reference to foregoing PROVING EXPERIMENT NO. 1, the reader will notice a high heat and quick cooling ingot method of making amalgam alloys. Dr. Black's amalgam graduates adopted somewhat the same method. They at least melted the metals together in a crucible and poured into iron matrix so as to cool outside sections of ingot quickly. This method results in a high heat molecular silver attenuation, which demands large mercury percentages, and makes the alloy quick setting. You will see that by low heat ingot method, Proving Experiment No. 1, amalgam fillings made with the same alloy and same melt, will be slow or slower setting and will shrink instead of expanding; whereas, the high heat ingot method, same experiment, will cause both expansion and shrinkage, or outrageous expansion, followed by crevicing.

The low heat ingot method, in which the alloy is allowed to cool slowly in and with the crucible itself, corresponds somewhat to Dr. Black's annealing process. During a slow cooling process, according to well established principles in physics, the high heat attenuated silver molecules

anneal and pull together and form large and complex or compound molecules. These larger sized molecules require less mercury and set more slowly, according as they increase in size. Read Physical Experiment No. 19. By the annealing process aforementioned, these molecules are made to pull together in the cut alloy filings or shavings after they are cold. This is a physical force which takes place in all compound and even in primary metals. High heat attenuated conditions with small molecular subdivisions have a tendency to become more complex and to granulate years after the metals are cold. The student will notice that in cooling physics, preceding paragraph, that during the cooling process that atoms, molecules and granules of gold, silver and zinc in melted tin have a physical attraction for each other. If cooled quickly the constitution at time of pouring will be fixed at once. If cooled slowly, the molecules will pull together during the time of cooling. If cooled quickly and cut into filings or shavings, the amalgam will be quick setting, reasons aforegiven. If the quick setting filings or shavings are heated according to Dr. Black's annealing method, these high heat attenuated silver molecules as parts of filings or granules will attract or pull together in the alloy, after it is cold. Annealing or heating the cut alloy hastens the change. The molecules will become more complex. They demand less mercury and set more slowly. It is well known that physical and structural changes take place in metals when they are cold as well as during the process of cooling, but that after cooled the application of heat at low temperature will make these changes more rapid. Amalgam alloys will self anneal if set aside in a room at ordinary temperature within eight months to one year. The same process may be obtained by heating the alloy in boiling water fifteen minutes. Boiling temperature fifteen minutes equals ordinary temperature, say 70 degrees, about nine months.

According to the foregoing physical, chemical, molecular and heat processes, Dr. Black's annealing process may be taken outside the domain of theory and become a scientific fact, a well known primary physical phenomenon.

HAIR SPLITTING AMALGAMS.—As early as the year 1902, it is evident that Dr. Black had not discovered that structural changes take place in amalgam fillings made with "new system alloys," same as all others. During that year he writes as follows: "The higher grades of alloys that are made according to the rules which I have given, do not shrink in setting. Some of them may expand very slightly, but there is no shrinkage following that expansion. You just understand that it requires exceedingly close work to make alloys that harden absolutely without movement. This can be be done, but whether it can be made in a commercial preparation is a question that is being slowly worked out by practice. It is fully demonstrated now that it can be done within one or two points, and we make these points expansion, not shrinkage. Most of the alloys that are going out from these makers (Dr. Black's amalgam graduates), are rated at one point expansion, which makes them perfectly safe against shrinkage. My examinations of the product show that the gentlemen who are making the alloys are working very close to this standard."

Please note that Black says that his amalgam graduates can make alloys which expand one or two points only in amalgam fillings made with them. One point is one 10,000th of an inch, a space so small

as to require the lens of a high power microscope to see. Instead of one or two points, amalgam fillings made with "new system alloys" will bulk change from a few to 300 points or more within one to five years from time of insertion.

TESTED ALLOYS.—The physical, chemical, and molecular constitution of crucible melt alloys and their amalgams as aforesaid, are so varied, uncertain and difficult to understand that even the ablest physicist cannot test them. Read preceding paragraph "Lost Physics." When these molecular constructions are so varied and differ so much in different batches of amalgam alloy by the same manufacturer, it is impossible to test and give the structural changes which may take place within one to five years or more. Shrinkage and expansion which takes place during the setting process, but not indicative, say twenty-four to forty-eight hours, may be measured with a micrometer, but the structural changes are not ascertainable. One ordinary sized amalgam filling may change but a few points, and another may bulk change to the extent of 300 points or more. The ablest physicists are not able to predict. "New system alloy" makers advertised "original tested alloys" and "expands one 20,000th of an inch" to good financial profit. Believing that Black's amalgam graduates could gain such stability in amalgam filling work, dentists used it, almost to a man. Now that they see that amalgam fillings made with New System Alloys swell up, shrink, crevice, or black ditch about same as before, some less it may be, alloy makers try to lay the blame on the dentist, with all sorts of complaints, such as, "don't mix it right"; "too much mercury"; "not packed tight," etc., etc., and etc.

BULK CHANGES A MYSTERY.—No attention heretofore has been given to specific causes of structural and bulk changes in amalgam fillings. This paper is the first in print to give a detail of the physics, chemistry and logic of such changes. Black, Vol. 2, page 308, second paragraph, discussing the amalgam problem, asks: *"What was the cause of these changes?"* without attempting in any way in all his thirty pages on amalgams to even guess at specific causes.

WRONG TIN AND MERCURY PERCENTAGES.—Black, Vol. 2, page 307. Experimental tests with mixed amalgam alloy, 65 per cent silver filings and 35 per cent tin. He made an amalgam, according to this formula, with mercury. He says it expanded badly without attempting to give the physical or chemical reasons for said movements.

LOGICAL REASONS.—Too much tin, about 10 per cent and consequently about 15 per cent too much mercury, which would of course make an amalgam filling, which would bulk change badly for several years. The action of the free excess mercury on the silver filings, would cause extended expansion until near to an equalizing of the physical force of mercury for tin and its chemical force for the filings. During the last stages of the knitting together process years later, such amalgam masses will shrink and crevice. For further logical reasons, see foregoing paragraph, "Tin and Mercury Percentages."

BULK CHANGES, GENERAL CAUSES.—All kinds of bulk or structurel changes in amalgam fillings, either harmful or harmless, are caused by the physical and chemical action of mercury on amalgam alloy structure, which has not been reached by that metal, during the grinding and kneading processes with mercury. These changes will be either shrinkage, expansion, crevicing, spheroiding, protruding, or tilting, or sloughing of margins. Their various specific causes have been indicated in preceding paragraphs. But the action of mercury on undissolved alloy metals and their compounds is one general cause! Specific causes result from the action of mercury on diffeernt kinds of amalgam alloy structures, that is, different atomic, molecular and hpysical conditions will result in different movements.

NO ATTENTION TO STRUCTURAL CHANGE.—Instruments, crushing machines and micrometers were devised by Black and early investigators, to measure bulk changes which took place during the setting. Black, Vol. 2, page 301 says: *"Most of them (instruments) had for their object the determination of shrinkage and expansion in the process of hardening and setting, as it was generally called."* The specific causes of subsequent structural changes, not even having been attempted by him and early investigators to discover. No attention whatever was given to this department of amalgam science in all his thirty pages on amalgams.

ADVISES BRAND AMALGAMS.—Black, Vol. 2, page 320, first paragraph says: *"Further, as cut alloys deteriorate in time, the date of the preparation ought to be placed on each package."* If amalgam alloys are made by right, logical methods of construction, according as given in preceding paragraphs, Amalgam Science in a Nutshell, age will not deteriorate them. Time will rather improve them, both in filings, granules, molecules, and strength in the amalgam filling.

CAUSE OF BLACK DITCHES.—Black, Vol. 2, page 317, says: *"But the cause of imperfect margins is another question, I found that it occurred from shrinkage of the amalgam, leaving the margins open, which redecayed again."* He did not even attempt to give the causes of shrinkage.

TIN SHRINKAGE AND MERCURY EXPANSION.—Black, Vol. 2, page 319, first paragraph says: *"I see no reason why the amalgam would not be made to expand just the same as if less tin had been used in making the alloy."* Evidently he had not studied the physics and chemistry of right and wrong tin and mercury percentages. See foregoing paragraph "Tin and Mercury Percentages."

FENCHEL-BLACK CONTROVERSY. In the 1910 January Dental Cosmos, and other recent numbers, Dr. Adolph Fenchel, Sc. D., LL. D., Hamburg, Germany, has papers discussing the constitution of pure tin-silver alloys, also the behavior of these metals in such alloys, the behavior of tin-mercury and the volumetric behavior of tin-silver alloys. In the 1910 March number of the Dental Cosmos, Dr. G. V. Black controvorts some of the views of Dr. Fenchel in regard to the physics, chemistry and behavior of these metals and alloys. In answer to these gentlemen, the writer will say as follows:

In your (each of you) several papers in the Cosmos, you discussed the constitution of pure tin-silver alloys, the behavior of tin-silver alloys, of tin-mercury amalgam, the volumetric behavior of tin-silver alloys and their volumetric behavior. The discussion leads you to a series of theories and conclusions to which I need not refer.

For reasons given in Keller's Amalgam Principia, and for further logical reasons given in this paper, the writer will say that there should be no tin-silver alloys, nor no compound silver-tin alloys fused together to molecular physics for the purpose of mixing with mercury to make amalgam fillings. If the alloy is made by a logical method of construction, there will be no intermixture of the high and low fusion metals, followed by volumetric misbehavior. If the alloy is made right, tin and mercury will not misbehave in the amalgam filling. If made right, neither will silver and mercury misbehave in the amalgam filling. If made right, the tin, silver, mercury and associate metals will be held in such secure, physical and chemical relations with and to each other, that they will have no chance to misbehave. Neither will there be any chance for volumetric misbehavior. It is only when the physical and chemical affinities are not properly proportioned and balanced by excess percentages of mercury, wrong formulas, and methods of making, resulting in loose and weakened affinities, that the metals will misbehave, or result in volumetric misbehavior.

The volumetric and misbehavior of metals with each other in the amalgam filling, such as shrinkage, expansion, spheroiding, crevicing and breaking down of margins and black ditches, result from crystallization processes. Different kinds of crystallization with different molecular alloy structures produce these specific and varied harmful results. Alloys should be made, as near as can be, so that there will be no formation of crystals with mercury. They can be, or quite nearly so, if compounded by logical and scientific methods.

It may be a surprise to you to know that tin, zinc, copper and gold can be fused together in a crucible without molecularly intermixing the high and low fusion metals. It is fundamentally wrong to intermix them, so as to gain high heat molecular attenuation. It is the high heat attenuated small crystal silver molecules and complex silver molecules, fused with tin, which causes the harmful crystalline structural changes in amalgam fillings. The only remedy is to quit making such alloy structures.

As to the best method to accomplish such results, you are respectfully referred to Keller's Amalgam Principia, and method of making coated granular alloys, given in this paper.

MICROSCOPES AND MICROMETERS NOT NECESSARY. Bulk changes in amalgam fillings have received more attention than any other department of their physics and chemistry. Soon after amalgam fillings first came in use, both shrinkage and expansion became noticeable to the naked eye. They varied in different fillings. Then inventive genius began to construct instruments for the measurement of expansion and contraction, as if measurements of movements would remedy them. All kinds of micrometer devices were made. If the invention of microscopes and micrometers to measure bulk changes would in any way have suggested or have been productive of a remedy to hinder them, then amalgam study by the able men of the profession in early amalgam history would have been properly directed, but such was not the case. The invention of delicate instruments to register shrinkage and expansion as small as one 20,000th of an inch had no possible benefit in the way of reducing these movements. If these inventors had given same study, time and ability to ascertaining the specific cause of shrinkage and expansion, which they did to measuring devices, they might long ago have discovered a remedy.

CAUSES AND REMEDY CORRELATED.—In all history, in medicine, art(literature, science, physics and mechanics, cause is the logic of remedy. Without knowing specific causes, remedies if gained at all, are only now and then, and by accident. Remedy without knowing cause is always a guess. Until the discovery of the tubercle bacillus, the cause of consumption, patients with the white plague scourge, were treated with little or no hope. Consumption most always meant certain death. As soon as the specific cause of this malady was discovered, the medical profession began to reduce and remedy. Knowing specific cause, cure is now effected in most cases. The same would have been the result in the physics and chemistry of amalgam fillings. If the early and later inventors had used their brains to discover specific causes, instead of measuring instruments, the amalgam problem might have been solved long ago. Specific cause suggests and enables remedy. Less microscopes and micrometers and more hard work and brains are necessary to learn and make fundamental progress in amalgam science.

SHARP ADVERTISING. "One 20,000th of an inch" is a space so small that it can only be seen through the lens of the highest power microscope. It is a phrase which has been extensively used during the last decade by sharp advertisers, for the sale of new system amalgam alloys, but instead of expanding one 20,000th of an inch, these alloys shrink, expand, spheroid, crevice or black ditch all the way from a few to 300 points or more within one to five years. Such stability cannot be gained. He who advertises it is a deceiver and a fraud. New system makers know that the dentist sees the error and have quit advertising "one 20,000th of an inch."

BULK CHANGES UNIVERSAL. Shrinkage, expansion and other movements in amalgam fillings will take place, no matter who may be the alloy maker, but in amalgam fillings made with properly formulated and constructed alloys, there will be harmless contraction and expansion. The movements will be so small as not to be deleterious and cause recurrent decay. Amalgam fillings made with improperly formulated and compounded amalgam alloys will have harmful contraction and expansion, resulting in leakage, black ditches and recurrent decay in proportion as the alloy is not properly made. Amalgam fillings will never be made with mercury which will not move, nor phosphate cements which will not dissolve.

WORSE! VERSE! CURSE!

"Oh, Doctor, it's the truth, Ruth's tooth
Is driving her insane; pain, strain
Is awful. With each night's blight, light
Of day comes ere will creep deep sleep.

"We're told, it's very true you do
Such work that plainly shows woes goes.
We hope you'll do the trick quick, slick,
And tooth that has disease please ease.

"Now Ruth, sit in the chair there where
The Doctor will, I know, go slow.
Open your mouth, don't sigh, cry, try
To be brave. Do you sweat yet, pet?"

But Ruth, dear little maid, stayed 'fraid,
Yelled, "Toothie on the lower more sore."
Said mamma, from the rear, "Here dear,
Hold my hand with your right, quite tight."

The dentist at her side, pried, tried
His forceps to insert—hurt. Curt
Remarked he'd "make that 'beaut' root scoot,"
But only touched the "bum" gum some.

And then he made a dab, stab grab,
And tried the tooth to sneak. Squeak, shriek
Resounded through the halls, bawls, calls,
And see upon the floor gore pour.

But forceps had a long, strong prong,
And held on with a flip, snip clip.
So mamma will for days raise praise,
As joyful as a grand-stand band.

A. S. Greenwood, D. D. S.

ABSTRACTS AND SELECTIONS.

A THEORETIC CONSIDERATION OF THE EXPANSION AND CONTRACTION OF GOLD WHEN CAST UNDER PRESSURE.

BY G. J. CLARK, D.D.S., CHICAGO, ILL.

One of the perplexing questions that has confronted the dental profession, and has been the subject of controversy and discussion since the process of casting metal under pressure has been practiced, is the question of shrinkage and expansion. Of all the literature I have read pertaining to this intricate subject I have, so far, failed to find anything that gave a correct exposition of this question, or depicted a true scientific portrayal of the metamporphosic phenomena the metal undergoes in its transition from the molten to the solid state.

I have read ably written papers comparing the shrinkage of gold when cast under pressure, to shrinkage of steel rails. I have perused columns of figures, carefully compiled, showing the degree of expansion and contraction of gold under normal conditions, but this is immaterial and not applicable; on the contrary, it is flagrantly fallacious when applied to gold cast under pressure, while the molten metal is confined within the unyielding embrace of rigid walls.

Of all the mechanical achievements that man can boast, there is not one that is not a modification of some mechanical principle utilized in the unfathomed laboratories of nature. In regard to the art of molding and casting, the same cosmic laws prevail with infallible accuracy, whether the proportions are the seething molten mass of an uncooled planet, or an insignificant globule of gold no larger than a pea. Science teaches that the planets and all the solar system, once existed in the form of nebulous or gaseous matter scattered throughout the boundless oceans of space, whirling and revolving, gradually cooling and growing denser, throwing off portions from what we may term parent bodies, and these cast off portions in turn throwing off other

portions from their mass, until this sort of process in time evolved our solar system.

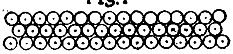
So for countless ages the matter of this earth existed in a molten state, gradually cooling and shrinking until the surface became rigid and the internal molten mass became encapsuled by a crust. As the shrinking continued, matter was called upon to supply the deficiency, and the crust being solid and rigid and held by the power of cohesion, the power of centrifugal force was greatest at the greatest circumference, and of course the portion of the revolving sphere that offered the least resistance (the poles) succumbed to the demands of the internal shrinkage and were drawn inward; and so we find the earth slightly concave at the poles.

The cooling of the metal in a mold, while not exactly similar, is strikingly analogous to the cooling of a planet or the earth on which we live.

Matter is never at rest; the atoms comprising the molecules revolving around a common center, forming a miniature solar system, are in a constant state of agitation, moving rapidly around in their medium of ether, and confined in their movement to the limited space between their fellows.

Now the outer surface of a mass of matter is the first to be susceptible to any thermal change, the effect being transmitted toward the center, and if this thermal change be of a sufficiently high degree to change the state of the mass from the solid to the liquid, or gaseous, or vice versa, the surface is the first to exhibit these manifestations. (Fig. 1.)

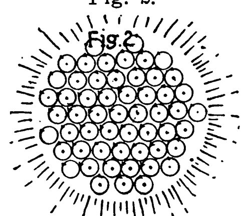
Fig. 1



Let us suppose Fig. 1 to represent a cross section of gold plate, magnified to such an extent that the molecules are visible, and represented by the small circles or spheres. Now, should this plate be subjected to a heat of a sufficient degree, the atoms of the molecules revolve more rapidly than before, become more divergent in thir tendency, describing a larger circumference about their common center, the molecules increase in the same proportionate volume, and their mutual power of cohesion diminishes, and this allows the molecules to separate more widely, and permits of a greater latitude in which to

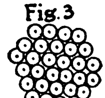
exercise their mobility. As the atoms are whirling about their common center the molecules are revolving, and revolving also about each other, generating centrifugal force to such an extent as to overcome the force of gravity, and with a tendency towards projection in every direction; held in restraint only by the still active but greatly diminished power of cohesion. This causes some molecules to be lifted above their fellows and as heat increases the mass begins to assume a globular form (Fig. 2) and presents a panorama of rhythmic harmonious action.

Fig. 2.



Now if the heat be withdrawn the revolutions of the atoms about their common centers decrease, and as their momentum gradually diminishes the atoms come into closer proximity, the molecules decrease in volume, the power of cohesion increases, the mutual attraction of the molecules becomes more intense, exhibiting more influence than the force of gravitation, and the congealing mass of metal retains more or less of the globular form; the molecules being caught in the act of falling much the same as water is caught and held in the formation of an icicle; see Fig. 3.

Fig. 3

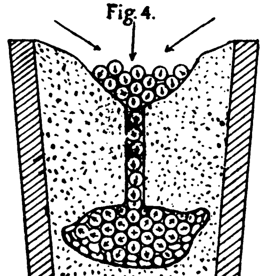


If this globule of gold were measured for its specific gravity it would be found that it developed, by the mutual attraction of its molecules (cohesion) a density that registers a relative specific gravity of 19.16. Thus, if gold, heated so as to assume the liquid state, be allowed to congeal uninfluenced by any interfering conditions, the only factors entering into the phenomena being mass, cohesion, heat, molecular mobility, volume and gravitation, it is a physical impossibility for the metal to develop, by virtue of its cohesive force, a density that registers a relative specific gravity above 19.16. In the casting of

metal under pressure, additional factors enter, and must be taken into consideration; they are hydraulic pressure and welding, the latter being induced by the force of hydraulic pressure.

If a mold has been prepared in the usual procedure for a cast under pressure, and is in a condition for the reception of the molten metal, a button of gold fused in the crucible manifests the same physical phenomena previously described and represented by Fig. 2. The atoms will revolve around their common center more rapidly than at a lower temperature, and the molecules will revolve around each other in like manner and the metal is gradually transformed from the solid to the molten or liquid state. If force now be suddenly applied to the liquid mass in the crucible a portion of it will be forced by displacement into the mold, and if the pressure be maintained for a time it will be transmitted from molecule to molecule simultaneously in every conceivable direction, the hydraulic force pressing the molecules to all surfaces and angles of the mold. As the molecules at the surface of the mass come in sudden contact with the walls of the mold their movements are abruptly checked, the atoms of the molecules are forced to closer proximity, the molecules decrease in volume and have less latitude in which to exercise their mobility, which instantly induces congealation; and as they are held firmly against the walls of the mold, gaps and crevices occur, which are, however, filled by the pressure behind, and with inconceivable rapidity, with new recruits, frenzied and heat-maddened, where they meet the same fate as their fellows, crushed and jammed against each other and the walls of the mold until in congealing a rigid wall or capsule lines every surface and angle of the mold. (See Fig. 4.)

Fig. 4.



This goes on in the same way until the surface crust thickens to the center, all following the same regular order of things, but with

no loss of appreciable time, in a small mass of gold as might be inferred from the deliberate description. This metal will be found to be of higher specific gravity than when it is allowed to cool under ordinary conditions. A pressure of 12 pounds induced by expanding gas, will bring about a density or specific gravity of 19.45.

The duration of time in which the metal is transformed from a molten to a solid state is exceedingly short, and the fact that the metal retains enough heat to maintain a red color for a time, furnishes no scientific proof that the metal in the mold will shrink, for the metal that remains in the crucible and the metal in the mold encounter conditions in hardening that are diametrically opposed. The metal in the crucible is confined by no walls, and the pressure on it being from without inward has no such effect as on that confined in a mold, for the reason that the hydraulic pressure that the confined gold is subjected to forces the metal from the center outwardly as long as it remains molten, and thus it is pressed against the cooler walls where the crust as described is formed, and which will register a density of 19.45, against 19.16 of that remaining in the crucible, and there is no inherent force or physical property in the metal itself after being cast under pressure capable of augmenting its density to any further degree, so it is physically impossible for it to shrink. Therefore, if in the process of making an inlay or a more extended piece by casting under pressure any distortion occurs, or it is not a fac-simile of the wax model, the discrepancy must be ascribed to some other factor or cause than the shrinking of the gold.

References consulted on Expansion and Contraction of Metals:
(Chicago Public Library.)

Clark, D. K. A Manual of Rules, Tables and Data for Mechanical Engineers, 1878. K 598.

Du Bois, A. J. Elementary Principles of Mechanics. Vol. 2, 1894. K 4982,2.

Dana, E. S. (ed.) American Journal of Science. Vol. 161, 1901. Ser.

Howe, H. M. Metallurgical Laboratory Notes. 1902. K 12780.

Hutton, W. S. Practical Engineer's Hand-Book. 1896. K 5405.

Lineham, W. J. Text-Book of Mechanical Engineering, 1894. K 4958.

Poynting, J. H. and Thomson, J. J. Text-Book of Physics. 1904. K 15930,3.

Rankine, W. J. M. Manual of Civil Engineering. 1891. K 661.

Useful Rules and Tables. 1873. K 665.

Thurston, R. H. Brasses, Bronzes and Other Alloys. 1900. K 5502,3.

Watson, W. Text-Book of Physics. 1905. K 15933.

—*The Bur.*

THE CENTRAL THOUGHT IN THE CONSIDERATION OF PULP AND PERICEMENTAL DISEASES WITH ESPECIAL VIEW TO DIAGNOSIS.*

BY OTTO E. INGLIS, D. D. S., PHILADELPHIA.

Aside from fermentative changes which occur in the mouth and act as the causes of dental caries, pyorrhea alveolaris, and pulp putrefactive changes, no subject is of such importance for the proper consideration of the pathology and symptomatology of pulp and pericemental diseases as those of hyperemia and inflammation. The contemplation of inflammation properly includes that of hyperemia, for it is really a series of hyperemic changes with the added pronounced feature of immigration of leucocytes and exudation of lymph.

A correct mental picture of arterial and venous hyperemia and of inflammation, coupled with a knowledge of the causes of these conditions, enables one to view with the mind's eye all the pathological conditions which are met with in clinical dentistry. A little imagination based upon a fine differentiation of grades of vascular disturbance enables one to diagnose with reasonable accuracy, and to apply indicated therapeutics with a success which does not attend a haphazzard judgment of the particular case. I am reminded in this connection of a lecture delivered by Professor Garretson some twenty years ago upon the subject of pleurisy, in which he said that a doctor sitting in his chair listening to a patient describing correctly the typical symptoms of a case, could correctly, and without leaving his seat to examine the patient, say at once, "A case of pleurisy." Many times I have applied this dictum to cases of dental practice. A good description of symptoms by the patient, perhaps brought out by a few well-directed questions, has enabled me before looking into the mouth to say to myself, "A case of hypersensitive dentin;" "A deep cavity somewhere about;" "A case of pericementitis;" "A case of pyorrhea alveolaris," etc., and I have been almost surprised at the frequency with which a glance has been sufficient to confirm the diagnosis, and in other cases only a short examination, the removal of a filling, etc., has been enough to confirm it. Do not understand me to say that a close search is not sometimes necessary, nor that doubt may not exist

*Read before the Connecticut State Dental Association, at its annual convention at Hartford, April 20, 1909.

when many teeth are possible causes of rather obscure reflex pains, but the general proposition of Dr. Garretson that "In the main, diseases tell all about themselves, if we have the knowledge to understand the symptoms," holds good in dental as well as other diseases.

To return, then, to our general subject, we may begin by defining arterial hyperemia as an overfulness of arterial vessels, due to a determination of blood to a given part as the result of reaction to irritation. So long as it remains such without an excessive immigration of white corpuscles it is arterial hyperemia.

In venous hyperemia the cause is essentially different, in that some obstruction to the vein prevents the return of blood to the heart rather than invites blood by irritation. A weakness of the heart or some inefficiency of the minor assistants to circulation, as the valves of the veins or thoracic movements, may cause a collection of blood in the veins, but this cause rarely acts in dental lesions. The backing up of the blood following venous obstruction produces tension upon the vessels, followed by diapedesis of red corpuscles and exudation of water fluid—the condition of edema. In inflammation arterial hyperemia appears as the first stage, followed by a collection of leucocytes along the walls of the small veins, and the immigration of some into the perivascular tissue. As this eventually leads to stoppage of the blood current, and even to stasis, the condition is essentially a venous hyperemia. Accompanying the immigration of leucocytes is an exudation of lymph, highly coagulable in character, which distends the lymph spaces in the tissue and produces the characteristic swelling.

In the consideration of arterial hyperemia we must take into account that if it be maintained there is an increased nutrition of tissue as the result of the excess of nutritive material in overfull vessels, and that in consequence the functions of all cells are increased. This expresses itself in constructions, such as hypertrophy, and in increased nervous activity or irritability and increased temperature due to increased oxidation. For these reasons we may expect in arterial hyperemia increased growth and greater response to tactile and thermal irritants. As the hyperemia increases these are also increased, so that a pulp or pericementum responds to irritants in accordance with the measure of increase in overfulness of the bloodvessels.

The results of venous hyperemia are opposite to these, in that,

as it increases, the venous blood held in the part has its nutritive supply exhausted and the backsetting prevents an influx of new blood. The result upon the cells is a loss of nutrition, less oxidation, and hence coldness of the part, and degenerative tendency in the cells.

In inflammation both tendencies occur in the different areas. Thus in the area of stasis there is coldness and degeneration, while in the surrounding area, which is in the stage of arterial hyperemia, constructive changes may occur if the inflammation be long enough continued, while in the intermediate area resorptive activity is apt to be set up as an effort upon the part of nature to remove an irritant.

Applying these principles to pulp and pericemental diseases, we find that when we have in the pulp a mild hyperemia, such as would result from the exposure of the dentinal fibrillæ to irritants, such as friction, chemical irritants, thermal changes, etc., there is almost immediately a constructive reaction. The odontoblasts produce transparency of dentin and secondary dentin opposite the area of injury, in an apparent attempt to close the tubules by the construction of new tubular substance (tubular calcification or consolidation), or to throw up a barrier within the pulp cavity (secondary dentin).

In slowly progressive dental caries the result is similar, for the same reason. As the pulp must atrophy to accommodate secondary dentin, it is often the case that another form of constructive change occurs, namely pulp nodules, and if the atrophy and degeneration continue there is apt to occur either death from vascular disturbance or further depositions of calcific material, without regular secretory activity, such as calcific degeneration. Strictly speaking, the degeneration probably precedes the calcific deposition, which should occur in the diseased area.

If more severe irritants act, such as thermal shocks through deep cavities, abrasions, erosions, fractures, ground teeth covered with metal, deep cavities filled with metal, septic dentin under a filling, or such as a blow or constant impact, as in the various forms of malocclusion, or when reflexes occur from other points of irritation, or when an area of inflammation existing in a nearby area extends in the direction of the apical tissue of the tooth in question, the pulp becomes overfull of arterial blood, and reacts to thermal irritants in proportion to the overfulness. It also produces in the odontoblasts a degree of hypersensitivity conforming to its own increased irritability.

A simple example will illustrate the nature of these responses to vascular overfulness. I one day caught my lower incisor outside of the upper, and the return of the jaw to its place produced sufficient force to strain the lower incisor a little. For a day nothing was noticed; later the lower tooth began to be slightly sore to the touch, and at the same time began to respond to cold water taken in the mouth. The next day it responded still more, so that it became necessary to shield it from cold substances. The next day the symptoms had subsided somewhat, and in a day or two more it was in a practically normal condition.

Perhaps an analysis of the pathology and symptomatology will be of value. First, pericemental injury followed by pericemental hyperemia; by simple contiguity an overflow of blood into the pulp followed, which produced increased irritability of its sensory nerves, hence the increased response to cold. In the recovery the pericemental hyperemia subsided, draining the pulp of the excess of blood, the pulp hyper-irritability subsided, and the response to cold lessened, until the normal non-conductivity of the enamel and dentin was sufficient to protect it against thermal shock. In this case it is probable that general dentinal sensitivity was also increased, rendering possible a painful fibrillar reaction by conduction of cold through the enamel.

If we analyze a common case of hyperemia through a filling or open cavity, we find a similar pathology working in the other direction. Thus from one shock some hyperemia of the pulp bulb results, mild in character. More shocks, more hyperemia, and as this goes on the thermal tolerance is lessened until the pulp is shocked by the slightest variation in temperature from the normal, even a breath of air being sufficient to start a paroxysm of pain. If the case be one which affects the entire pulp a pericemental hyperemia is liable to be produced, which renders the tooth tender to touch. This is especially noticeable in profound pulpitis, with which there is always associated some hyperemia. The overfulness of the pulp vessels causes an overflow into the pericementum, which thus becomes hyperemic.

The anatimical situation of the pulp, boxed up in unyielding dentin, compels the artery and vein to lie side by side at the single apical foramen. As the enlargement of the artery necessarily compresses the vein, it follows that a venous obstruction is set up. The blood is held back in the venous system of the pulp, while an increased influx enters by the arterial vessel. The result is necessarily

increasing vascularity of the pulp by venous hyperemia. For this reason profound arterial hyperemia usually ends in venous hyperemia, and not infrequently the diapedesis of red corpuscles and the solution of their hemoglobin causes the pulp and the dentinal fibrillæ to be stained pink. Even with a congestion of this degree the pulp may live for some time, even months, even though the bulb may be dead, which to my mind, argues for a collateral circulation in the pulp tissue, which some prominent observers claim does not exist.

Looking at this pathology from a clinical point of view, we would expect to find, first, an increasing response to cold as the arterial hyperemia increases, and a decreasing response as the bulb undergoes stasis and degeneration, while in the intermediate stage the extreme paralysis and distention of the bloodvessels may lead to continuous boring pain, and when the pulp is opened, to profuse bleeding which may not readily subside.

The therapy of these hyperemias, of course, depends upon the nature of the cause. If due to conduction of thermal changes, these must be corrected by non-conductors or by the shielding of the tooth.

If the hyperemia be not too severe, as after gold filling in cavities of moderate depth, the pathology may be considered as either produced primarily by conduction or it may be argued that the injury of the fibrils has produced a pulp reaction favoring a response to cold. In either case counter-irritation and shielding often have their reward in a subsidence of symptoms after a few weeks.

In carious cavities, sedation and the use of non-conductors are usually effective, except in cases of exposure of the pulp, which is then better devitalized, as a rule. In this same devitalization, if arsenic be used, we have to consider the death of the pulp through the production of a rapid venous hyperemia superinduced by the devitalizing action of the arsenic. In the death of the apical portion of the pulp the pericementum often becomes hyperemic. This view, which is clinically proved by experience, removes the fear of apical arsenical necrosis in well-developed teeth. In cases of external injury or extension of an area of inflammation into apical tissue, the cause should be removed and the general principle of rest, counter-irritation, and possibly general derivation employed, without any resort to interference with the pulp undergoing reaction.

In profound venous hyperemia of the pulp, sedation often fails,

and only depletion by pricking the pulp, or in some cases burring out the bulb under nitrous oxid anesthesia, will give relief from the pain. The pulp must be destroyed.

In acute inflammation of the pulp we have many of the symptoms of hyperemia, because the inflammation is a hyperemic condition, plus the characteristic immigration of leucocytes and exudation of lymph. The pain is heavy, continuous, and boring, or may be lanciating or jumping. In the later stages recumbency allows the blood to flow into the paretic vessels, which may excite to pain a previously quiet pulp. Pain in response to tapping is due either to concussion of the inflamed pulp or to associated hyperemia of the apical pericementum. When exposure exists, suction, pricking with a pin, etc., the pressure of food in mastication, chemical irritants such as salt, sugar, acids, and the products of fermentation or bacteria, may individually produce pain.

If pyogenic organisms have reached the pulp and infected it, pus probably forms, either upon the surface of the pulp or in its substance. If the pus is confined, pain in response to heat and relief from the application of cold are the chief symptoms, though passage from one temperature to another or touching with the tongue will often excite pain. Sometimes the venous hyperemia proper, or that associated with inflammation, will have caused death of the pulp bulb, and this becoming infected and putrefied, the gases formed cause a peculiar delayed reaction to heat, though in quite a number of cases the predominant symptom has been a tenderness to touch, as though an abscess were forming—that is to say, pericementitis is present. I have quite often found in the canals of teeth root-fillings overlying living pulp remnants which were supposed to have been removed years before. In one case as many as twelve years had elapsed between the time of root-filling and the serious irritability of the pulp. In such cases are found combined, pain in response to heat, or even to cold, and pericemental tenderness.

There is often present, occurring at intervals, a sudden stab of pain, a sthough a wire had suddenly been run into the pulp, which pain may cease immediately. In other cases reflexes to some other part occur, simulating so-called trifacial neuralgia.

A considerable portion of the pulp may be alive, so the inference is that any pericemental reaction is due to extension of inflammation from the pulp, though the possibility of apical infection from the

infected pulp, cannot be wholly ignored, especially as in some cases distinct gingival or even facial swelling occurs. Upon opening and removal of the dead portion of the pulp and the use of an antiseptic dressing, there is seldom any further sign of abscess.

The total death of the pulp from venous hyperemia or inflammation is gangrene, which may, however, be partial in many cases. Here we have two varieties: First, the dry form, in which the pulp, under aseptic conditions, shrivels to a thin thread, a condition very rarely to be found; second, and very common, moist gangrene, in which the moist dead pulp admits bacteria which cause it to putrefy. The chief consideration in the pathology of this is its action as a chief cause of apical abscess, or sometimes non-purulent pericementitis of chronic nature.

Often leakage of gas through dentinal tubules forms a sufficient vent to prevent abscess formation. Thus the patient complains of a bad taste in the region of the tooth—which, however, may be due to decomposing material in an ordinary cavity or to stagnant food collected between the teeth or about the margin of a rough filling.

Sometimes pain in response to heat or the passage from a warm to a cold atmosphere, and *vice versa,* is sufficient to start apical irritation. This symptom is, however, more often associated with abscess of the pulp.

As one would expect, the tooth is discolored by iron sulfid as a rule, the dentin is insensitive to cutting, the chips have a foul odor, and the passage of an interrupted electric current produces no shock. These symptoms, or lack of them, together with opacity to transmitted light in more doubtful cases, are plain evidence, yet in previously treated teeth some imagination and courage and careful procedure are required to remove an apparently good root-canal filling from a tooth which has a portion of dead pulp in an imperfectly filled root-canal, and which is causing chronic apical inflammation without actual apical abscess. Here again, however, an odor is usually perceivable, and careful removal of the root-filling usually unearths the expected gangrenous pulp remnant within the apparently empty apical portion of the root-canal, into which a very fine Swiss broach will usually pass as soon as the canal obstruction is removed.

That the apical abscess is an inflammation is a matter of course, but the phenomena of sequential desire to handle the tooth, tenderness, soreness, and exquisite soreness are all significant of the degree

of irritation of the pericementum, while the slight extrusion and finally elongation and painful malocclusion are symptomatic of the amount of exudation present. The character of the swelling upon the gum and the facial involvement are also full of meaning as to the advancement of the suppurative process in its passage through the bone and gum.

A definite condition of apical absecess is not usually difficult to diagnose, if one remembers that such a state is due to moist pulp gangrene in all cases not recently subjected to infection by instrumentation, and the clinical picture becomes clearly defined mentally if we recall the pathological phenomena of infective inflammation. Located in apical tissue, the swelling of the same causes extrusion of the tooth and looseness, while the inflammation present causes the tenderness to touch. Here, though, we have refinements of the pathology in a series of phenomena varying from simple desire to work the tooth with the fingers to facial swelling and looseness—the degree of involvement, of course, being dependent upon the extent of the suppurative inflammation, the resistance of the tissues, and the capacity of the individual for endurance. In diagnosis the symptomatology of moist gangrene is always to be considered.

Other refinements may be carefully thought out, namely, why pus appears first, then blood, upon venting a tooth; why pus sometimes does not appear; which root is affected; whether a pyorrhea pocket or a dead pulp is the cause of an abscess apparently apical; why a fistula cannot be washed through from the root-canal, and many other complications which may arise in treatment.

Many times I have seen in dental literature a reference to dry gangrene of the pulp, with a description of a foul canal appended. Dry gangrene is of very rare occurence, at least as applied to the whole pulp. The pulp is probably so affected in many cases of root mumnification, but I believe that a true dry gangrene rarely causes trouble. It is rather putrefaction, which involves liquefaction, and gas formation as its end product, to which we must attribute the apparently dry but foul canal sometimes observed clinically. Of course, the pulp being dead, the dentinal insensitivity and opacity are present in dry gangrene, as will also be a shrunken and fibrous pulp remnant. In such a case subsequent infection may cause apical abscess.

In non-septic pericementitis we have the same general considerations of hyperemia and inflammation without the formation of pus.

The tooth may be as tender, or more so, than in the septic form, but a history of the tooth, its subjection to external violence, or internal, mechanical or chemical injury, to apical tissue, leads one to careful differentiation from infective inflammation.

In this connection I would point out the relation of a non-septic pericementitis to a septic one. Just as a case of arterial hyperemia of the pulp due to pyorrhea located in the pericementum, or an abscess upon an adjoining tooth, can only occur through previous irritation of the apical pericementum—or possibly a reflex—so this pericemental reaction must be looked upon as an extension of inflammatory action from a septic site, yet in itself to be aseptic, for in most cases the septic area is circumscribed. It may extend and involve the previously asceptic area but still there will remain an aseptic area which may involve another pericementum, or a more remote portion of the same pericementum. It is for this reason that we may have in the same pericementum a pyorrhea, which is a suppurative or infective inflammation of the pericementum primarily, associated with degrees of vascular disturbance which produce on the one hand construction, as in hypercementosis, and on the other destruction, as in resorptions of cementum.

In like manner may we consider gingivitis, both marginal and interstitial, as being either septic or non-septic in nature, and whichever it is we may look farther for a non-septic area, and often, as previously stated, for reactions, such as pulp hyperemia, which may seem of distinct nature but are really simply extensions of hypermic areas into a peculiar anatomical situation.

The neuroses associated with these hyperemic and inflammatory states are simply nervous reflexes, often difficult of exact etiological determination, but frequently by the aid of careful differentiation and explanation, or by the aid of the Roentgen ray, are referable to definite pulp or pericemental reactions.

While this paper has necessarily not dealt with many factors underlying dental pathology, and especially not with constitutional factors, which may be in the main regarded as predisposing rather than exciting, I believe that the essential views which must ever be kept in mind in diagnosis, particularly in obscure cases requiring differentiation, have been presented, and if they prove to be of as great comfort and utility to my hearers as they are to me daily, I shall be repaid for my trouble.—(*Dental Cosmos.*)

TO DRILL GLASS.

It is said that with the tool moistened with the following, glass can be drilled, filed and otherwise manipulated with tools such as are used in metal working: Pulverized camphor, 2 oz., sulphuric ether, 6 dr., oil of turpentine sufficient to make six ounces.—*Scientific American*, March 5, 1910.

HOW ELECTRICITY PRODUCES HEAT.

Whenever electricity is flowing through a wire the temperature of that wire is more or less raised above the surrounding atmosphere. The amount of heat developed depends upon the nature of the conducting wire and its size. It is a fact that every path through which electricity flows offers some obstruction to its flow. This quality is known as resistivity, and the resistance of a definite length of wire of a given diameter of any material can readily be measured. If in a circuit of low-resistance copper wire a small piece of fine platinum wire, having a very high resistance, is introduced, a current which will barely warm the copper wire will heat the platinum wire white hot. This is because the electricity, so to speak, has to work hard to get past the platinum obstacle in its path, and this work produces heat.

Upon this very principle all the electric heating devices of today are constructed. Take, for instance, the electric chafing dish. Without the above explanation it is difficult for the layman to understand where the heat comes from which cooks the fudge or the Welsh rarebit. One can see no flame, nothing that ever looks as though it might be hot, yet the contents of the pan is bubling away, emiting clouds of steam. When the flexible cord is connected to the electric light socket and the current turned on the electricity flows down the wires in the cord to the "resistance" concealed in the bottom of the chafing dish. This "resistance," a leaf of special alloy metal, does not allow the current to pass readily, and the energy expended in overcoming this causes it to get very hot.—*American Review of Reviews.*

STERILIZATION OF THE SKIN BY TINCTURE OF IODINE.

A method of sterilizing the skin is suggested by Dr. Grossich who applies a 10 or 12 per cent tincture of iodine to the field of the opera-

tion and to the surrounding skin without any preliminary scrubbing with water. His investigations have shown that the tissues absorb the iodin much more readily when they are dry, and that it penetrates deeply into all the seams, with soap and water. The water softens the epidermal cells and they swell and plug the openings. He relates his experience with this technique, especially in a large number of cases of open, crushed wounds in laboring men. The parts are shaved dry, and then painted with the tincture of iodin, and a sheet is then laid over the naked patient with a hole over the field of operation—the sheet fastened to the skin with a few small clamps and reaching to the floor all around. After anesthetizing the patient, the field of operation is painted a second time with the tincture of iodin, and the completed suture is swabbed anew with it. He has never seen any by-effects from this technique, not even when a third of the body was painted with iodin. This technique Grossich believes eliminates all danger of infection from the patieent. He applies it only when the wound is still entirely free from signs of inflammation such as redness and swelling. If the tincture of iodin is applied after the parts have been recently scrubbed with soap and water, there is much more danger of suppuration; it is indispensable that the tissues should be dry when the iodin is applied for sterilizing purposes.—A. GROSSICH, M.D., Leipsic, *Zentralblatt fur Chirurgie,* Bd. XXXV, No. 44.

PULP ANESTHESIA WITH ETHYL CHLORIDE.

N. A. FINKELSTEIN, D.M.D., Boston, Mass.

By the use of ethylchloride spray the immediate removal of pulps, especially in anterior teeth, becomes a simple, painless, and rapid operation.

To do the operation successfully, the operator must work with dispatch and have all the necessary instruments within easy reach. It is to be remembered that the tissue is frozen, and that if the operation is delayed the frozen tissue will lose its anesthesia and the result will be contrary to success.

The way to prepare for the immediate removal of the pulp with ethyl chloride spray is to have a round bur of medium size attached to the engine, and a serated broach ready for use; then all the mucous

membrane, except that over the root of the tooth to be operated upon, is protected with napkins. No rubber dam is used, as it prevents the ethyl chloride spray from being directed on the mucous membrane. The vial containing the ethyl chloride is held about a foot and a half from the mouth and the spray is directed upon the tooth and the exposed gum above the tooth.

When the gum and tooth present a white and frozen appearance, the spray is stopped and the exposure enlarged with a round bur, the broach is immediately inserted into the canal and the pulp removed in the usual way. Then wipe out the canal with a solution of adrenalin chloride, and if conditions are such as to deem it necessary to fill the canal, do not hesitate in doing so, but it is preferable to put a dressing of hamamelis for a day of two and then fill the canal.

If done properly the whole operation for the removal of the pulp does not take two minutes and the result is a rapid and painless extirpation and a grateful patient.—*The Xi Psi Phi Quarterly.*

A DENTIST'S REVENGE, OR ROSS' PRIZE STORY.

A Chicago dentist's revenge on a patron who refused to pay his bill is related by Thomas W. Ross, who plays the leading role in "The Fortune Hunter" at the Olympic. Dr. R. W. Bane is the dentist referred to. The dentist had filled a molar in the lower left jaw with silver and fruitlessly waited for his pay. Six months later the opposite tooth was affected. The dentist placed a copper filling in the cavity. The moment the patient closed his mouth a strong circuit was established between the opposite metals, almost jerking the jaw off the patient.

"I can't stand this, doctor," cried the man.

"Well, you will have to stand it till you pay my bill," replied the dentist, whereupon the money was immediately forthcoming and a new filling was put in.

CHLORO-PERCHA FOR PULP CANALS—HOW TO MAKE.

Select a jar holding two to four ounces and fill it about one-third full with pink base plate gutta-percha cut into strips or squares sufficiently small that they will settle well to the bottom of the jar. Pour over this enough chloroform to well cover the gutta-percha and allow it to stand a few hours closely covered. By this time it should be fully dissolved; if not, add more chloroform. Shake well and allow the sediment to settle to the bottom. The gutta-percha we now have is loaded with impurities that should not be in a gutta-percha used for pulp canal filling; to remove them strain it through a cheesecloth. Now add about two or three drams of thymol crystals to each ounce of gutta-percha. As the chloroform evaporates add oil of cajuput to keep it fluid. After some months the chloroform will all be evaporated and the gutta-percha will be held in solution by the oil of cajaput. This chloro-percha will be ropy and tenacious, not so short-grained as that made from base plate gutta-percha unstrained.—*Dominion Dental Journal,* December, 1909.

PREPARING THE GUM MARGIN BEFORE SETTING PORCELAIN CROWNS.

When preparing a root to receive a porcelain crown it usually happens that the gum margins are somewhat torn; at times they protrude slightly above the surface of the root, this, and the blood and mucus interferes with accurate adjustment, and with the proper setting of the cement. This may be avoided by sealing the end of the root with gutta-percha for a few days after it has been prepared to receive the crown. This protects it, allows the gums to heal, and the pressure of the gutta-percha forces the gum tissue away from the root sufficient to secure a more accurate and more securely cemented joint. Now and again, when circumstances permit, the nearly fitted porcelain crown may be "set" with an excess of temporary stopping for a few days with decided advantage. It thoroughly exposes the root end and favors accurate adjustment.—ADOLPH ENGEL. D.D.S., Philadelphia, in *Pacific Dental Gazette.*

Our Foreign Department

THOMAS L. LARSENEUR, D. D. S., Foreign Department Editor

NOTE:

Owing to a lack of space in April issue we were compelled to omit three tables relating to Vaccine Treatment of Pyorrhea Alveolaris. We here below give these three tables:

Case.	General Symptoms.	Organisms Ismolated.	Opsonic index.	Result of treatment.
1.	Slight anæmia; acne; occasional diarrhea; "indigestion"	Staphylococcus albus	0.8	Cured.
2.	Moderate anæmia; loss of weight; constant malaise	Pneumococcus Misrococcus catarrhalis	0.5 0.7	Cured.
3.	Anæmia; recurrent ulceration of buccal surface of cheeks	Streptoccoccus longus	0.4	Cured
4.	Desquamation of palmar surface of hands; tox¾mia	Micrococcus catarrhalis Streptococcus longus	.. ..	Cured.
5.	No general symptoms	Stapylo. citreus granulatus	4.0	Cured.
6.	Recurrent facial neuralgia; paroxysmal	Diphtheroid bacillus	0.6	Relieved.
7.	Rheumatoid arthritis; fever	Catarrhalis type Saccharomyces neoformaus	0.7 2.2	Refused treatment, died.
8.	Chronic rheumatism, knee, shoulder and wrist joints	Streptococcus longus	0.7	Relieved.
9.	Toxæmia; anæmia	Diphtheroid bacillus	0.6	Cured.
10.	Chronic pharyngitis; anæmia	Staphylo. Albus Staphylo. citreus granul	2.0 0.7	Improved; relapsed.
11.	Rheumatoid arthritis, hands and wrists; anæmia	Staphylo. aureus Streptococcus	0.7 3.0	Relieved.
12.	Recurrent aphthous ulceration of cheeks and tongue	Streptococcus longus	0.6	Cured.
13.	Constipation, alternating with diarrhea; toxæmia	Streptococcus longus Staphylo. citreus granulatus	0.7	Relieved.
14.	Persistent headache; nausea; anæmia; weakness of flexor of wrists and fingers	Pneumococcus Staphylococcus aureus	2.7 0.3	Cured.
15.	No general symptoms; large hard diffuse swelling outer angle of mandible	Diphtheroid bacilli	0.8	Cured.
16.	No general symptoms	"Bacilli"	1.6	Cured.
17.	General malaise; toxæmia	"Bacilli"	0.4	Cured.
18.	Acute paroxysmal neuralgia	Diphtheroid bacillus	0.4	Much imp'v'd.

CASES WITH MODERATE LOCAL SYMPTOMS OF TYPE II.

Local pus formation; individual teeth unaffected; irregular infection of alveolar process; osteosclerosis as well as rarefying osteitis.

Case.	General Symptoms.	Organisms Ismolated.	Opsonic index.	Result of treatment.
1.	Acne	Streptococcus longus Bacillus acne	1.8 0.2	Cured.
2.	Toxæmia; post rhinitis; furunculosis	Straphylococcus aureus Streptococcus longus	0.6 1.2	Cured
3.	Lymphatic enlargement; toxæmia; muscular rheumatism	Streptococcus longus	0.7	Cured.

4.	Toxæmia. acute	Streptococcus longus	0.5	Cured.
5.	Acne	Staphylococcus aureus	0.5	Greatly improved.
6.	Tox¾mia; loss of weight; chronic headache	Staphylococcus aureus	0.7	Cured.
7.	Toxæmia (cardiac); herpes of nose	Staphylococcus aureus Staphylo. citreus granulatus	0.4 0.6	Cured.
8.	Toxæmia; fever	"Strepto-bacillus"	0.5	Relieved.
9.	Anæmia	Streptococcus longus	0.3	Cured.
10.	Chronic dyspepsia	Staphylococcus aureus Saccharomyces neoformans	1.4 1.4	Cured. Cured.
11.	Vomiting; toxæmia; anæmia	Staphylococcus aureus	0.6	Cured.
12.	Anæmia; headache	Pneumococcus	..	Cured.
13.	No general symptoms	Streptococcus longus Staphylococcus albus	0.7 2.0	Relieved. Relieved.
14.	No general symptoms	Streptococcus longus Micrococcus catarrhalis	2.7 0.6	Relieved. Relieved.
15.	Anaemia; general malaise	Micrococcus catarrhalis Staphylococcus aureus Streptococcus longus	0.8 0.8 0.9	Cured.

CASES WITH SEVERE LOCAL SYMPTOMS OF TYPE III.

General pus flow from alveolar margins; loosening of the teeth; absorption of the alveolus; bleeding gums; abscess formation.

Case.	General Symptoms.	Organisms Ismolated.	Opsonic index.	Result of treatment.
1.	Toxæmia; gastro-intestinal	Streptococcus Staphylococcus albus Micrococcus catarrhalis	0.7	Relieved but relapsed.
2.	Toxæmia	Staphylococcus albus Staphylococcus citreus granulatus	0.6 0.5	Relieved.
3.	Toxæmia; diarrhœa	Staphylococcus aureus Staphylococcus longus	0.5 1.3	Cured.
4.	Anæmia; nausea	Micrococcus catarrhalis	0.3	Relieved, but relapsed.
5.	Anæmia	Micrococcus catarrhalis Streptococcus longus Staphylococcus albus	0.5 1.7 0.5	Cured.
6.	Gastro-intestinal; cardiac	Diphtheroid bacillus (septus) Staphylococcus aureus	3.0 0.8	Cured.
7.	Severe toxæmia; anœmia; prostration	Staphylococcus aureus Streptococcus longus	3.5 ..	Cured.
8.	Insomnia; dyspepsia; secondary neurasthenia	Pneumococcus Micrococcus catarrhalis	0.4 1.0	Cured.
9.	Chronic toxæmia; breathlessness	Staphylococcus aureus Micrococcus catarrhalis	0.3 1.1	Cured.
10.	General weakness; pharyngitis; glossitis; acute toxæmia	Micrococcus catarrhalis (?) Saccharomyces neoformans	0.6 0.6	Cured.
11.	Gastro-intestinal; much diarrhoæ; toxæmia	Staphylococcus aureus Streptococcus longus	0.6 1.7	Not treated; developed ulcerated colitis.
12.	Toxæmia; rheumatoid arthritis.	Staphylococcus aureus Pneumococcus	0.5 2.3	Relieved; still under treat.
13.	Toxæmia; pharyngitis; vomiting; "neuritis" of the arm.	Streptococcus longus Saccharomyces neoformans	0.6 0.7	Cured.
14.	Toxæmia; obstinate constipation; anæmia; secondary neurasthenia	Staphylococcus aureus Bacillus necrosis	0.8 ..	Cured.
15.	Lymphatic leukæmia	Staphylococcus aureus	2.6	Died.
16.	Acute toxæmia; fever; vomiting; anæmia	Staphylococcus aureus Pneumococcus	.. ..	Cured.
17.	Anæmia; chronic nausea; toxæmia; wasting	Staphylococcus aureus Pneumococcus	0.8 0.6	Cured.
18.	Acute facial neuralgia; toxæmia; neuroœdema	Staphyloccoccus aureus Streptococcus longus	0.8 0.7	Cured.

TO THE DENTAL PROFESSION OF AMERICA.

At the December, '09 meeting of the Ohio State Dental Society it was unanimously resolved that an American Memorial be established to perpetuate the memory of the late Dr. Willoughby D. Miller, as an evidence of the profession's appreciation of his laborious and fruitful researches for the scientific advance of dentistry.

From the concensus of opinion of various state and local societies it was decided that the memorial take the form of a monument, to be erected in a suitable public place in Columbus, Ohio, the capital of Miller's native state. The monument to consist of a life size bronze of Dr. Miller, mounted upon a granite base of suitable proportions with appropriate tablets, the cost of which will approximate $8,000.

Though his scientific career was in a foreign land, the great pride he showed in his American citizenship, the love for his profession in America, and his final plans for educating students in his own country in the line of work he had so ably begun, should make this memorial movement National in its scope, and to this end the committee in charge has selected honorary committees in the several states to cooperate in bringing this matter to a successful issue.

This movement has received the endorsement of the National Dental Association. Ohio will raise $1,200 for this fund and it is the desire of the committee to have one tablet to state that contributions were received from representatives of the profession in every state of the Union.

Contributions are desired from individuals as well as societies, in fact, many small subscriptions are preferable to a few large ones.

The committee has selected Dr. Weston A. Price, 10406 Euclid avenue, Cleveland, Ohio, to act as treasurer of this fund, and to him all subscriptions should be made payable.

That your state may be represented in this fund and appear in the published list of subscribers, we ask your earnest support. Your response to this appeal will be the measure, not only of the success of our committee but of the appreciation of American dentists for one who raised the standard of the profession.

Yours very respectfully, EDWARD C. MILLS, Chairman.
16 South Third street, Columbus, Ohio.

J. R. CALLAHAN, 25 Garfield Place, Cincinnati, Ohio.

S. D. RUGGLES, Portsmouth, Ohio.

MEETINGS

ALUMNI ASSOCIATION OF THE COLLEGE OF DENTISTRY.

The Alumni Association of the College of Dentistry, University of Illinois, will hold their third annual clinic and meeting on Wednesday, June 1, in the college building, corner Harrison and Honore streets. This will be a strictly alumni clinic but a cordial invitation is extended to ethical members of the profession to attend the clinics.

FRANK J. RYAN, Secretary.

THE MICHIGAN STATE BOARD OF DENTAL EXAMINERS.

The next regular meeting of the Michigan State Board of Dental Examiners for the examination of applicants for registration will be held at Ann Arbor, beginning Monday, June 20, and continuing through to the twenty-fifth. Application must be in the hands of the secretary at least fourteen days before the examination, and should be addressed to A. W. Haidle, secretary-treasurer, Negaunee, Mich.

THE NATIONAL ASSOCIATION OF DENTAL EXAMINERS.

The twenty-eighth annual session of the National Association of Dental Examiners will meet at the New Savoy Hotel, Denver, Colorado, commencing Monday, July 25, at 10:00 a. m. The rates will be $2.00 per day for one and $3.00 per day for two persons in room, European plan; large room for one or two with private bath $4.00 and $5.00 per day.

Meeting and Committee rooms at the service of the association free and every accommodation extended. An early mail reservation is requested, the time being the busy season. A full representation from every state in the United States is desired.

J. J. Wright, D. D. S., president, Wells building, Milwaukee, Wis.; Charles A. Meeker, D. D. S., secretary, 29 Fulton street, Newark, N. J.

IOWA BOARD OF DENTAL EXAMINERS.

The Iowa State Board of Dental Examiners will hold a meeting for the examination of candidates for license to practice dentistry in Iowa, beginning June 6, 1910, at 9 a. m., at Iowa City.

For blanks and other information, write

E. D. BROWER, Sec'y, Le Mars, Iowa.

INDIANA STATE BOARD OF DENTAL EXAMINERS.

The next meeting of the Indiana State Board of Dental Examiners will be held in the capitol, Indianapolis, beginning Monday, June 13th, and continuing for four days. All applicants for registration in the state will be examined at this time.

No other meeting will be held until January, 1911.

For further information, apply to the Secretary,

F. R. HENSHAW,
507-8 Pythian Building, Indianapolis.

WISCONSIN STATE BOARD OF DENTAL EXAMINERS.

The next annual meeting of the Wisconsin State Board of Dental Examiners will be held in the Dental Department of the Marquette University, Milwaukee, Wis., beginning June 20, 1910.

All applications for examination must be in the hands of the secretary, together with a fee of $25, fifteen days before the examination.

For further information, address

C. S. McINDOE, Secretary.
Rhinelander, Wis.

SOUTH DAKOTA STATE BOARD OF DENTAL EXAMINERS.

The South Dakota State Board of Dental Examiners will hold its next regular meeting at Sioux Falls, S. D., July 6, beginning at 9 a. m., and continuing for three days. All applications fo rexamination, together with a fee of $25, must be in the hands of the secretary by June 26. Applicants who have not complied with the above will not be permitted to take the examination.

G. W. COLLINS, Secretary.
Vermillion, S. D.

PERSONAL AND GENERAL

Poison Kills Dentist.—Dr. W. T. Martin, a dentist at Issaquah, Washington, died April 8th from an overdose of laudanum. He was a sufferer from a painful malady and was in the habit of taking laudanum and it is believed he took an overdose.

Dentist Commits Suicide.—Dr. Henry A. Hampton, a dentist of Longmont, Colorado, committed suicide April 19th by shooting himself in the head. The doctor was 35 years old and is survived by a wife and two children.

Denzler-Swezey.—Dr. John Denzler, of Kearney, Nebraska, and Miss Lucile Swezey, of Marengo, Iowa, were married Tuesday, April 12th.

Body of Missing Dentist Found.—The body found in a corn field near Covington, Kentucky, was positively identified as that of Dr. Addison C. Deputy of Indianapolis, Indiana. It was evident the man had been dead fully a week. The main artery in his right arm was cut but no knife was found near the body. Mental conditions are believed to have caused him to kill himself.

Dentist Commits Suicide.—Dr. H. J. Johnson an invalid dentist, of Springfield, Illinois, committed suicide May 1st by taking poison. Despondency over financial affairs is given as the cause.

Mueller-DeWolfe.—Dr. C. W. Mueller, a prominent dentist of Rock Island, Illinois, and Mrs. Ethelyne De Wolfe, were married April 18th at Peoria, Illinois.

Dentist Sent to Jail.—Dr. T. L. Clayton, claiming to be a resident dentist from Shreveport, La., was arrested at Fisher, La., for illegally practicing dentistry. He pleaded guilty to the charge and was fined $5.00 and costs or thirty days in jail. He is now serving the jail sentence.

Dentist Insane.—Dr. Frank R. Cunningham, a dentist in Los Angeles, Cal., was declared insane by the Lunacy Commission April 5th and a guardian appointed for the $6,000 estate.

Dentist Accuses Wife.—Dr. William P. Sanders, a dentist in St. Louis, Mo., has filed suit for divorce against his wife on grounds that she became involved in a love affair with another man.

Testing Dental Law.—The case of the State of Missouri against Dr. U. G. Crandell and Dr. George W. Northwood of St. Joseph, Mo., wherein they are charged with having practiced dentistry without a license came up on a demurrer in the criminal court recently. The defense is questioning the constitutionality of the law vesting the State Dental Board with power to license dentists.

Ball Player and Dentist.—Jack Hayden, Hoosier outfielder, who is hitting the ball on the team, is thinking about taking steps to become registered as a dentist in Indiana. Though a graduate in dentistry, Hayden did not take the examinations in his native state, Pennsylvania, necessary for registration. He graduated from college in 1902 and went in strong for baseball to the injury of dentistry.

Dentist for Mayor.—Dr. W. H. Gregory, a dentist in Florence, Ala., has made formal announcement of his candidacy for mayor, subject to the action of the voters in the regular city election to be held in September.

Dentist Acquitted of Murder.—Dr. J. S. Cahill, a well known dentist of Rocky Mount, Va., who was charged with the murder of Robert Smithers, was acquitted by the jury.

Saved by Parrot's Jabber.—Dr. Cora E. McCrew, a dentist in Holton, Kansas, was saved from fire April 29th by the jabbering of her parrot.

Retires from Dentistry.—Dr. B. P. McDonald, who has practiced dentistry for the past fifty years in Goshen, Indiana, will retire.

Dentist Practiced Illegally.—Dr. George B. Saxenmeyer, a dentist in Jersey City, New Jersey, was tried for practicing illegally and adjudged guilty. Saxemeyer is a graduate of the dental department of the University of Pennsylvania and has been practicing a long time but refused to accede to the demand of the state board to take an examination. He alleged there was a prejudice against him.

Retired Dentist Seriously Injured.—Dr. Armstrong, a retired dentist of Hagerstown, Indiana, in attempting to put a halter on a vicious colt in its stall was crowded against the side of the manger with such force that a shoulder blade was broken. The broken bone pierced the flesh to the surface and internal injuries were also suffered. His condition is serious.

Dentist is Held on Theft Charge.—Dr. Thomas N. Kidd, one time practicing physician and dentist of Baltimore, Maryland, was arrested April 14th in Oklahoma City, Okla. He was wanted on a charge of burglarizing the premises of his former employer.

Dentist Sues Patient.—Dr. Robert Good of Chicago, Illinois, has brought suit against Miss Nellie Anheuser, daughter of a St. Louis millionaire brewer, for $500.

Suit to Recover for Dental Work.—Dr. G. A. Clark of Eau Claire, Wisconsin, has filed suit against Mrs. A. T. Tenneson, of the same place, to recover a balance of $40 for dental work performed. The contention of the defense was that the defendant was a married woman and therefore not liable and that the work was unsatisfactory and was never accepted by the defendant.

Dentist Going to India.—Dr. L. H. Writ, a dentist of Muncie, Ind., has gone to Bombay, India, to practice dentistry.

Damage Suit.—Suit was filed in the city court, April 27th, by Miss Mary Garoughty against Dr. J. D. Lanier, a prominent dentist of Macon, Georgia, for damages in the sum of $15,000. The petitioner alleges that she has been injured and damaged in the above mentioned sum by Dr. Lanier.

Damages from a Dentist.—A verdict of $6,000 was rendered by a jury in the supreme court of Rochester, New York, April 25th, in favor of Helen Byers, five years old. The child's parents sued Dr. Frank W. Cady, a dentist of Rochester, N. Y., for $25,000 damages alleging that the defendant broke the child's jaw in extracting a tooth, with the result that her face was disfigured.

Dentist Divorced.—Dr. Benjamin C. Green, a prominent dentist of Keithsburg, Illinois, has been sued for divorce by his wife, Mrs. Bertha V. Green, on the charge of nonsupport. The divorce was granted in the Denver, Colorado, court where Mrs. Green has gone for her health.

Dentist, Justice of the Peace, and Harp Maker.—Dr. L. S. Field, dentist and justice of the peace in Sugar City, Colorado, is the only man west of Chicago who manufactures Italian musical instruments from crude material. Dr. Field learned the art of making Italian harps in his boyhood under an old expert harp maker in Iowa, and although he afterward graduated in dentistry and took up the profession as his life work, his fondness for the work would not allow him to entirely abandon the making of his favorite instrument. The harps he turns out have been pronounced by experts equal in tone and finish to any produced in Italy.

Robberies.—Drs. Overholser & Wilkins, Sterling, Ill., loss $25.00; Dr. G. L. Kelton and Dr. W. T. Rowland, Van Buren, Ark., loss $100; Dr. D. C. Hopkins, Jonesboro, Ark., loss not given; Dr. S. A. Campbell, Mattoon, Ill., loss $500; Dr. Shoop, Leavenworth, Kansas, $75; Dr. Myers, Leavenworth, Kansas, $35; Dr. Renz, Leavenworth, Kansas, $140; Dr. Johnson, Leavenworth, Kansas, loss not given; Dr. Peterson, Mankato, Minn., loss $10; Dr. Snider, Ft. Scott, Kansas, loss $50; A. R. Cuyler & Co., Dental Supply House, Omaha, Nebraska, loss $500; Drs. G. C. Carruthers, $30; Dr. J. L. Goodson, $230; Dr. H. O. Seifert, $40; Dr. O. L. Frazee, $50 Dr. A. E. Converse, $50; Dr. H. G. Nelch, $30; Dr. G. Munroe, $25; Dr. C. N. Neal, $150; Dr. A. Lambert, $25; Dr. B. L. Renfro, $45; Dr. Theo. Knoll, $50; Dr. W. C. Somner, $75, Springfield, Ill.

Fire.—The dental office of Dr. W. V. Chapin, Dallas, Texas, was destroyed by fire, May 3d, loss was about $250.

Robberies.—Drs. W. A. Baker, loss $250; R. R. Freeman, loss $50; Dr. F. A. Odermatt, loss not given; all of Tuscan, Arizona. B. E. Black of Madill, Okla., $3.00; Woodford Tilley, $40; W. L. Sanderson, $50; A. W. Martin, $175; Richard Sprake, $50; Dr. Keyt, $75; Green, $35; Denver, Colorado. C. F. Boggess, Harry Lee, L. P. Long, W. H. McCall, C. D. Schweitzer, C. R. Shacklette, Steinberg, J. H. Baldwin and J. B. Thompson, Louisville, Kentucky, total amount stolen, $2,000.

NECROLOGICAL

Dr. D. H. M'Neill, for ten years a practicing dentist in Athens, Georgia, died at his home in that city, March 3d. He was for many years secretary of the Georgia State Dental Association, and was a leading man of the profession. He was high in Masonic fraternities, being a Mystic Shriner, also prominent in K. of P. and the Elks.

Dr. W. B. Cassil, a dentist in Walla Walla, Washington, died suddenly from a stroke of apoplexy.

Dr. J. M. Harrod of Scottsburg, Indiana, died recently. He was sixty years of age. Death was caused by heart failure. Dr. Harrod has practiced dentistry for forty years. He was a veteran of the Civil war, having served as regimental bugler for the One Hundred and Forty-fifth Indiana Volunteer Infantry at Harpers Ferry. He leaves a widow and two sons.

Dr. V. H. Hobson, a prominent dentist of Richmond, Ky., and brother of Judge J. P. Hobson, member of the Court of Appeals, accidentally fell from the loft of the new garage which he was building, fracturing his skull. He died a few moments later without having regained consciousness. He is survived by a wife and five children.

Dr. William Jarvis a practicing dentist in Claremont, New Hampshire, died April 17th at the home of his brother, Dr. Leonard Jarvis. Death was due to cerebral hemorrhage. The doctor was a former president of the New Hampshire Dental Society and for six years served as U. S. consul at Milan, Italy.

Dr. W. Treat Payne, a prominent dentist in Darion, Conn., died at his home April 15th.

Dr. M. R. Stover, a prominent dentist of Casper, Wyoming, died April 9th of acute heart trouble. He was 33 years old and a member of the Masonic fraternity. The body will be sent to Norwich, Ontario, for burial at the doctor's former home.

Dr. I. A. Stitt, a dentist in Peru, Indiana, died April 28th from heart disease. The doctor was 52 years of age and is survived by a wife and seven children. He was a member of the Knights of Pythias and the Masons.

Dr. J. O. Gilbert, one of the best known dentists of Atlanta, Georgia, and brother of Dr. William L. Gilbert, president of the Board of Health, died Saturday, April 16th, from heart trouble. He was 36 years old and is survived by a widow and two daughters.

Wanted | For Sale | Exchange

NOTE:—Advertisements in this Department not exceeding fifty words will be published **Free** for three insertions for subscribers whose subscriptions have been paid for **one year in advance.**

Advertisements under regular heading from non-subscribers will be inserted for a charge of five cents per word. Remittance in full must accompany such copy.

Copy must be on file in our office by the 15th of the preceding month in which insertion is desired.

In answering these advertisements through the American Dental Journal, enclose your answer in **stamped** envelope with the advertiser's letters marked on the corner. **No unstamped letters will be forwarded.**

We are not responsible for any advertisement appearing in these columns.

PUBLISHERS.

POSITION WANTED — Competent dentist, graduate '05, desires position in ethical practice, with view of investing. Chicago preferred. Address "M. L. C.," care American Dental Journal.

WANTED—Interest in advertising office in city, not over 300,000, smaller preferred, by up-to-date, reputable dentist; twelve years' experience managing one of the largest dental offices in country; reason, tired of large city. Address "Change," care American Dental Journal.

FOR SALE—One-story brick office building, with best practice in city of 3,500, located in heart of Blue Grass section of Kentucky. Fine opening for capable ethical man. Address F. O. Humphreys, Harrodsburg, Ky.

FOR SALE—Hurd gas outfit. First class condition, $15.00. One S. S. W. Wilkerson leg base chair, arm bracket and cuspidor included. $35.00. Write for further particulars if interested. Address "E. L. S.," care American Dental Journal.

FOR SALE—$95.00 Ransom & Randolph Cabinet, No. 38. All refinished. Price, $50.00. Also many other bargains in cabinets. Full particulars if interested. Address. "B. J. H.," care of American Dental Journal.

FOR SALE—One Ranson & Randolph cabinet No. 28; good as new; cost new $35; will take $15 cash. Address "Cabinet," care American Dental Journal.

FOR SALE—Gasometer tank, iron stand complete with tubing and inhaler, ready to use. How much? Address "S. M.," care of American Dental Journal.

WANTED—A-1 Prosthetic man, also first class operator. Ethical practice. Fine city and climate. Opportunity for right man. Address "Texas," care of Ameircan Dental Journal.

FOR SALE—Up-to-date dental outfit, town of 2,500, in the famous Palouse wheat belt, Washington. Modern electric equipment; practice established 20 years; $1,250 cash will buy outfit; a snap for the right man. Don't write unless you mean business. Address Washington No. 1, care of American Dental Journal, 39 State street, Chicago, Ill.

FOR SALE—Dental office in a small town in western Iowa. Rich farming country. Only small amount of cash required; established six years. Owner desires to leave state and go west. Address for particulars, West, care American Dental Journal.

FOR SALE—Ethical practice and office outfit. Established four years. All strictly modern, associated with M. D., reasonable rent, good location, reason for selling, going into another business. Beloit, Wis., inhabitants 18,000, 92 miles from Chicago. Address "P. K.," care American Dental Journal, 39 State street, Chicago.

FOR SALE—Or will exchange, dental practice located North side, Chicago, for practice in Texas. Will sell at $500.00. Address "Rix," care of American Dental Journal.

WANTED—A good all around laboratory man. Will pay a good salary to the right man. Address "Laboratory," care American Dental Journal.

FOR SALE—In Oklahoma, a modern ethical dental practice, substantial cash business, $4,000 per year, established nine years; population 12,500; only three other dentists, all congenial, with same fees. If you mean business, write now. Address Okla., care American Dental Journal.

FOR SALE—Advertising office and practice in Washington, D. C., on the largest business street. Office thoroughly equipped and outfit nearly new. A good investment for any advertising man. Address Interested, care American Dental Journal.

FOR SALE—I am going to retire from practice, I have a good outfit in a fine location that I will sell on easy terms at invoice to right party. Have been in practice eighteen years and can swing a large amount of business to buyer. Address "X," American Dental Journal, Chicago.

FOR SALE—Dental office and practice, established four years. Favorite Columbia Chair, Fountain Cuspidor, Clark R. & R. Cabinet, cost $85, Hurd Gas outfit, Full Laboratory outfit and reception room furniture. Average receipts, $275.00 per month. Price, $700.00. Address "B. J. B.," care of American Dental Journal.

FOR SALE—Dental office in town of 10,000, in Nebraska. Ethical practice, $3,000 per year. Price, $1,000. Will give terms. Address "Walk," care American Dental Journal.